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# Comprehensive Renewable Resource Management:

## Human Ecology at Sweet Briar College

by the faculty and students of the
Renewable Resources Management Class of 1990

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# FOREWORD

I came to Sweet Briar in the Fall of 1989 for a position as Visiting Assistant Professor/ Director of Environmental Studies. Among the attractions of Sweet Briar College were the beauty of the natural setting, the existence of extensive sanctuaries, and the potential for looking at the college from the point of view of a human ecologist. How was the human institution interacting with the natural ecosystem?

The Dean's office brought to my attention a publication which seemed to offer an appropriate model for investigating how educational institutions interact with the natural resource base. The publication In Our Backyard: Environmental Issues at UCLA, Proposals for Change, and the Institution's Potential as Model, a master's project published in June, 1989, was purchased by the Friends of the Sweet Briar Library. This publication planted the seeds which grew into this work by the students of the Renewable Resource Management class in the spring semester of 1990.

Mr. Tom Connors, Vice-President and Treasurer of Sweet Briar College, informed me that Sweet Briar College did not have a comprehensive natural resource plan, but that there were a number of people and committees at Sweet Briar who took responsibility for different facets of the environment. He has been most cooperative in providing Environmental Studies with the names of these people and committees.

In the Spring of 1990, ten Sweet Briar students met at our first class and discussed the possibilities of what we might investigate. Students chose areas of the environment that they most wanted to address. With support from two students in the Pollution class, our efforts formed a reasonably comprehensive, although not totally inclusive, picture of Sweet Briar's interactions with the environment. One student, Kirstie Rothauge chose to focus on interactions among all the resources and served as overall editor of our work.

Our class went on a variety of field trips into the community including the physical plant, the ozone monitoring trailer, Sweet Briar's water treatment plant, the Amherst sewage treatment plant, the forest sanctuaries, the dairy, and the landfill. People from the soil, water and forest extension services and the Virginia Air Quality Control Board as well as Tom Connors attended our class to let us know how their positions influence human interaction with the environment. Although this work cannot be considered a totally comprehensive renewable resource plan for Sweet Briar, I think it can be viewed as a beginning for how we ask questions about the human/ environment interface and how we draw up plans for the possible futures we might choose to create.

The overarching focus question of this work is "How does Sweet Briar interact with Energy and Matter in its Ecosystem?" For the energy focus, heat and light generation were investigated. Two pilot studies on electricity use supplemented this work. The basic principle of how we interact with matter can be summed up in the statement, "There is no such thing as Away," or "Everything goes somewhere." Students investigated our interactions with the atmosphere, both indooors with a look at indoor pollution and outdoors with a focus on global warming. Water resources included investigation of water quantity and water quality with emphases on water treatment and sewage treatment. A water taste test survey supplemented this work. Our interactions with land resources emphasized forest uses including recreation, sanctuaries, and managed woods, agriculture, pesticide use, and solid waste management. A preliminary cost/benefit analysis of recycled paper supplemented this work.

The views expressed in this document are those of the authors. The hope is that this initial effort will prove useful to Sweet Briar's many committees which interact with the environment. Perhaps future student research may fill in gaps we have left or extend any one of the foci further. It is also hoped that this holistic approach will help illuminate the environmental interactions and trade-off's that are inherent in our institutional decision-making.

Dr. Jane Heinze-Fry
Director, Environmental Studies

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Without the students, this document would never have been written. Primary writing responsibility goes to members of the Renewable Resources Class: Elaine Barksdale, Ulrike Fischer, Dianne Hayes, Angela Hickman, Karen Hott, Jennifer Jarvis, Renee Merion, Tricia Pheil, and Laju Shrestha. Thanks to Kay Pierce for her preliminary cost/benefit analysis of recycled paper use and Jennifer Valentine for her contribution to the water resource report. Acknowledgement for initial editing goes to Kirstie Rothauge and final editing to the Drs. Heinze-Fry.

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# PART 1

# ENERGY: GENERATING HEAT AND LIGHT

Living in a society where energy production is commonplace, we take for granted there will be heat, light, and plenty of electricity to provide for our consumer demands We depend on energy. Yet, we use it unwisely. Given the past energy crises and our current dependence on nonrenewable resources, including half our oil from foreign countries, it is important to examine the multiple facets of energy supply and demand.

When considering energy issues, it is important for us to remember the first and second laws of thermodynamics which govern the natural world. First, "there is no free lunch." We cannot get something for nothing. Second, "we cannot even break even." In any energy transformation, some energy is degraded or "lost" as heat. Our goal is to increase the efficiency of energy transformations.

Our society obtains most of its energy from nonrenewable resources. Each resource has its costs and benefits. Coal is the cheapest fuel. Known U.S. reserves could support current use for several centuries. Coal yields more carbon dioxide ($CO_2$) per unit of energy output (Btu) than any other common fuel, increasing global warming the fastest. Its impurities are the chief cause of acid rain and cause perhaps 50,000 Americans to die prematurely each year (Office of Technology Assessment 47). Oil is easily portable, much cleaner than coal, and yields only 2/3 as much $CO_2$ per Btu as coal. However, burning it in cars and trucks is a major source of acid rain and the chief cause of smog. Oil comes increasingly from abroad. Natural gas has virtually no polluting impurities, yields only half as much $CO_2$ per Btu as coal, contributes only a little to acid rain, and is cheaper than oil. It is harder than oil to transport and store, and, like oil, known resources will support only a few decades of current use. Nuclear energy provides electricity for many communities with no local air pollution. Problems include safe disposal of spent fuel (and retired reactors), conversion of plutonium to nuclear arms, high capital costs, rising operating costs, and risks of accidents like Chernobyl that can kill 100,000 people. All these fuels have industrial death rates associated with mining and facility operation: scores to hundreds of deaths each year; e.g., immediately from cave-ins and explosions, and much later from black lung disease and radiation-induced cancer deaths.

Renewable resources also have their costs and benefits. Water and wood are cheap. Hydropower creates no air pollution and is extremely cheap once dams are paid for. But it often inundates large amounts of land, creating and impacting aquatic ecosystems where it is located. Forests can be clear cut to fuel wood-electric plants.

Particulate and hydrocarbon emissions from home wood stoves are acute problems in some locales. Geothermal and wind power are cheaper than fossil fueled power in some places. Geothermal plants give off brine and gases like hydrogen sulfide. Wind turbine farms offer noise, TV interference, and unsightliness. Some solar cells use arsenic and cadmium, while central solar electric generation uses lots of land, and home solar heaters can spring leaks (Pimentel, et al.) But home generation eliminates transmission lines and makes our society less vulnerable.

While economic necessity is part of our decision-making tools, dependence on nonrenewable resources is impossible over the long run. We should realize that for our society to continue, we must develop reliance on renewable energy resources. We need to learn to plan for short, medium, and long term development options. We need to consider both centralized and decentralized options. We need to recognize that all of our energy decisions yield benefits and costs.

# CHAPTER 1

# ENERGY: HEAT

by Dianne Hayes

## Introduction

Most members of the Sweet Briar community take for granted that buildings will be heated. But few consider the source of the heat. Sweet Briar's heating practices have changed slowly with the years. Adherence to tradition precludes use of many innovative, relatively new, and unprecedented ideas. From its beginning, Sweet Briar has relied on fossil fuels, primarily coal, for its heat. Sweet Briar is also limited by the high cost of new technology. By the time these "new" ideas are economically acceptable, they are no longer innovative, relatively new, or unprecedented. A transition to use of renewable resources, such as solar energy, and more efficient environmentally benign resources like natural gas may not be far away.

Many heating systems around the country are based on burning of coal. The major problem with burning coal and many of the other fossil fuels is that carbon dioxide ($CO_2$) along with nitrogen oxides ($NO_x$) and sulfur oxides ($SO_x$) are released by burning. These gases contribute to the greenhouse effect and are primary causes of acid rain (Lemonick 39). Because of this, one of the major issues faced in deciding what heat source to use, along with energy efficiency, is what effect it has on the environment. In the early 1800s, the presence of $CO_2$ in the atmosphere was between 280 and 290 parts per million (ppm ). Today this value has risen to more than 350 ppm (Lemonick 38). The problem with this high concentration of $CO_2$ is that, as industry expanded through the Industrial Revolution, the plants and the oceans could no longer absorb all of the gases (Lemonick 37). The leftover gases began crowding into the atmosphere, enhancing the "greenhouse effect" which normally occurs in nature. Some forms of energy production create less carbon dioxide, and other greenhouse gases, than others and are thus , on this particular criterion, more environmentally acceptable. (For more information on greenhouse gases, see Chapter 3.)

Three energy sources are viewed as being highly usable and emitting lower greenhouse gases: natural gas, solar, and nuclear power. Natural gas has a wide resource base, is burned very efficiently, and is the cleanest fossil fuel burned (Burnett and Ban 305). It contains virtually no sulfur, a major acid rain contributor (Burnett and Ban 306). Solar power is viewed as the energy of the future. It is not yet cheaper than other methods, as in 1988 it cost three times more than fossil fuels (Begley 67). The cost of solar energy has fallen as research has progressed, and the nation is still pursuing an economically feasible way of capturing and storing more of it. The solar energy that falls on the earth in one day, if converted, could meet the power needs of the nation for 18 months (Begley 67). Although nuclear power, like solar power, produces no greenhouse gases, it is low on the public opinion scale. Most people shy away from it now because of recent accidents, notably Chernobyl, whose effects the world is still feeling. The world is still uncertain about radioactive waste disposal, the potential use of wastes in nuclear weapons, and of risks of accidents in the plants themselves (Sagan "Keynote").

The major advantage of coal is that reserves in the U.S. are far more plentiful than other fuels (What Everyone Should Know... 3). Coal becomes more acceptable when it is cleaned. Physical coal cleaning by removing pyrites reduces sulfur emissions by 8 to 34%, while chemical coal cleaning may lower them by 25 to 95%. Both can increase heat value and combustion efficiency significantly (OTA 161-163). Physically cleaning coal can remove a quarter of the mined material. Coal cleaning also removes certain particulate matter found in ash and covering smokestacks. Clean coal reduces dust accumulation in smoke stacks, allowing coal to burn more efficiently. However, coal cleaning does not reduce nitrous oxide, another major acid rain component (Kestner). Health problems are associated with coal mining, and even coal advocates admit that coal produces more $CO_2$ than gas and oil. Because of this, environmentally conscious groups oppose its use (Brown 88).

## Heat Production at Sweet Briar

An interview with Mr. Kestner, Director of Planning and Construction at Sweet Briar, provided the following information about Sweet Briar's past and present heat production. Sweet Briar originally used "assembly required boilers" (Kestner). As technology advanced and Sweet Briar grew, it became more economical to bring in a new boiler system. The new boiler, a single retort (one stream) boiler (Photo. 1-1), is used to heat all of Sweet Briar. There is also an oil boiler housed in Sweet Briar's physical plant that can run on kerosene, asphalt, gas, or "practically anything else." It is used as a back-up in case of a terribly harsh winter.

Sweet Briar's single retort boiler actually uses a mixture of coal and sawdust. Coal burns more economically with sawdust mixed in as fewer unused particles of coal are left over. The coal/sawdust mixture is burned on top of grates with air pumped up through it, heating water that runs through a pipe at the top of the boiler. The water turns to steam, is transferred to buildings, and condenses back into hot water.

Photo. 1-1. Sweet Briar Physical Plant. A mixture of coal and sawdust are burned to generate heat.

This process recycles 90-95% of the water. A major difficulty with Sweet Briar's system is its inability to run at maximum efficiency because of variability in demand.

Sweet Briar's stack emissions are cleaner than regulations require. Reasons include use of low sulfur coal and mixing sawdust with the coal. The emissions from the stack include nitrogen oxides, carbon dioxide, water vapor, and sulfur dioxide, all of which are below regulatory levels. The stack incorporates a "multi-cone separator" which separates particulate matter from the emissions. This separator was installed in the early 70s, after the Clean Air Act was passed.

Mr. Kestner states that natural gas would be a good option for the future, but currently the natural gas connections are too far away to be economically feasible. The closest link to the natural gas pipeline would be up Highway 130 about five miles past Elon. The cost to connect Sweet Briar, by itself, to the line would range around $2 million. Mr. Kestner explains that the interest alone on paying for it would greatly surpass the savings gained by using natural gas. He surmised that when, and if, Amherst gets a little larger and could also benefit from the connection to the pipeline, it might be more economically feasible for Sweet Briar to switch over to natural gas.

## Heat Retention

Heat use requires an understanding not only of heat production, but also heat retention. Simple insulation techniques can save hundreds of dollars in energy costs. A simple insulated roof on a local hospital in a little town in Iowa shaved 20% off the utility bill! The total conservation program in this little town saved them an estimated $1.2 million in energy costs in 1988 (The Good News 39). All they did was use simple insulation techniques! In the nation, new techniques and better management of lighting, heating and ventilation systems have cut $45 billion from energy bills (Rosenfeld and Hafemeister 78).

Sitting on a radiator upstairs in the main library, one can feel a chill coming through the window. That's a good indicator that the library lacks energy efficient windows. Windows generally have a low resistance to keeping heat in and cold out. This resistance level is called a substance's "R-value" (Rosenfeld and Hafemeister 82). The R-value can be raised by a second glaze to the normal single-glazed window, doubling its R-value. Because windows are the number one source of energy loss, it is advantageous to get the highest R-value possible. A window's R-value can be increased again by adding a low-emissivity (low-e) film to one of the glass surfaces to reflect infrared radiation (Rosenfeld and Hafemeister 83). This simple insulation technique is a possibility for Sweet Briar's near future, in that it does not change the campus' appearance. Low-e glass incorporates a practically invisible sheet of metal that lets only visible light in and reflects heat back towards the source (Hayes 28). If the heat is coming from the outside, as in summer, it is reflected back outside. If the heat is coming from the inside, as in winter, it is contained inside.The problem with using low-e glass in the new renovations and buildings is that at the moment it is too expensive to be feasible (Kestner). Although low-e glass has a high insulation value, the cost to replace them if they get broken is too high to fit into Sweet Briar's budget.

When Sweet Briar was built around the turn of the century, there was no concept of insulation. Around the 1930s when interest in the "insulation" concept grew, Sweet Briar began insulating its buildings. As the years passed, new techniques and ideas for insulation developed and again Sweet Briar re-insulated. Some buildings on campus, including the library and Reid Dormitory, have basic insulation, but insulating windows weren't yet invented when they were built. Mr. Kestner explained that by fixing it so that one can get wooden-framed windows, such as those in Reid and the library, open in the summertime when the wood expands, they are also fixed so as to allow the cold air to seep around the sides during the wintertime when the frames contract. In the new renovations and the prospective new dorms, Sweet Briar is converting to double paned windows, which double the heat retention of the current windows. This should cut down on a portion of the heat loss that Sweet Briar is currently experiencing. When economically more feasible, the use of low-e glass, along with re-insulating around the windows, could cut Sweet Briar's energy losses drastically. This re-insulation is also a good transition from our coal powered campus to at least a solar supplemented campus.

## The Future

Solar energy has a long way to go before it will be used on this campus for two main reasons: visually it goes against the architectural style of the campus and it is not yet economically feasible. Currently in Virginia, without tax credits, home solar hot water heating makes economic sense for very few households, including none with natural gas (Heinze Fry 134-144). Sweet Briar, however, has a great setting for solar energy because of its open southern face, which could be used to advantage. Passive solar heating is one possibility, but would have to be installed in renovation stages, a slow process with approximately one building a year. The Graduate School of Architecture and Urban Planning at UCLA agrees that the passive solar design of buildings is an economical way of conserving energy (In Our Backyard 397). (For more information on solar energy and power, there are many books out on the market, including Design For A Limited Planet by Norma Skurka and Jon Naar.) Another possibility to consider is the generation of solar electricity as a back-up supply for peak demand times. Natural gas is also a possible future if it becomes more economically possible to utilize on the campus.

As Sweet Briar grows and expands, solar power could be the energy source of its future. At the moment, though, the physical plant has a good, efficient, clean system that is keeping the school warm. Perhaps money saved from re-insulating buildings could be invested in a pilot solar cells project to see how solar energy might work at Sweet Briar.

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# CHAPTER 2

# ENERGY: ELECTRICITY

by Angela Hickman

## Introduction

Electricity is a pervasive form of energy, generated mainly by coal, uranium, oil, natural gas, and falling water. Electricity generation accounts for over 1/3 of U.S. energy use, and for 5/6 of coal production (CED 3). In the early history of the United States, wood was the primary energy source. In the mid-1850s it was overtaken by coal, mined at half a billion tons annually for many years. After World War I, oil and gas began to compete with coal and eventually displaced it as the nation's principal fuel. Currently, coal provides only 22% of the nation's energy, with natural gas providing 23% and petroleum 40% (USDOE [1990] 13&37, corrected for omission of wood, API 62, Fisher 12, Ruedisili 17).

World-wide electricity generation has grown steadily over the past century, averaging 7.2 % a year. During this time, the efficiency of electric generation rose dramatically, as the technologies of construction, operation, and maintenance have improved. This lowered the cost of electricity considerably. Until the energy crisis of the mid-1970s, few people saw limits to energy resources. Only after the crisis did most people realize their finiteness. It became evident these nonrenewable resources needed to be conserved. More renewable resources needed to be exploited, entailing further research into energy alternatives and the technologies necessary to make them available to consumers. Coherent long-range planning and management programs as well as improvements on existing technologies were also neeed (Fisher 94, Ruedisili 9).

These needs are as pressing as the U.S. enters the 1990s as they were 15 years ago. We are still researching, improving, and developing technologies to increase the efficiency of existing systems, as well as developing and marketing viable alternatives. We are disseminating research findings and information in general to facilitate research and educate the public. We support and practice conservation strategies; yet, much remains to be done. The responsibility for conservation is passed from generation to generation. We will always be energy consumers, and, as our numbers and the amount of our consumption increase so, too, does our responsibility.

## Electricity Use at Sweet Briar

Here at Sweet Briar College, we share this responsibility. Before our college was founded, a plantation occupied our premises. Wood was burned to provide heat. Kerosene lamps provided light. Shortly after the college's founding a reciprocating steam engine generator was installed to provide electricity. It was operated by a fireman from 7 a.m. to 10 p.m. During the remaining hours of the day and the early morning, there was simply no electricity available. This generator was replaced with a switchboard in the 1930s. When the switchboard was hit by lightning in 1948, the present Westinghouse switchboard was installed. Modifications made on the switch gear during March 1990 doubled its electric power capacity. A new main breaker was installed, along with a single capacitor to replace the many needed before (Kestner).

During September 1989, the college used 5,934,400 kWh of electricity at a cost of $220,440. (The Riding Center and the Wailes Center are not included in these figures.) This averaged 3.71 ¢/kWh. This was under the old contract, which billed the kW demand portion of the bill based on 15 minute peak periods. That means the college was billed for the highest usage occurring during any fifteen minute time interval each month. The college is charged for the actual kWh it consumes, its monthly peak demand, and its power factor (the efficiency of the electrical usage from a transmission viewpoint). Under the new contract with Appalachian Power Company, the college is charged for its peak demand during 30 minute time intervals, which should yield a slightly lower cost. In addition, the college is not charged for the power factor because its current power factor is so high: usually 97%-99% (Kestner).

As the dorms are being renovated, air conditioners and ceiling fans are being installed for the first time. These increase the college's electric demand from May until October,by an estimated 12%, or about $2,000 more a month. This cost could be slightly alleviated if all students would practice energy conservation behaviors, like keeping windows closed when air conditioners are running, and turning the fans on when they are needed most. Wearing appropriate attire for the weather conditions would also help. In addition, each degree that the thermostat is raised saves about 5% on air conditioning costs (Duquesne Light).

The college's outside lights first used incandescent light bulbs. About 20 years ago the college switched to mercury vapor bulbs. About 10 years ago more efficient high-pressure sodium bulbs replaced them, yielding a more pleasing golden light. Halogen lights are located around the tennis courts. All outside lights are on timers or, mostly, photocells. For security reasons all outside lights and lights inside stairwells are kept on at night. Campus police make sure they are on during their regular patrols around the campus (Police Chief Neil).

Fluorescent light bulbs are in all the offices and academic buildings on campus. The newest and newly renovated dorms have fluorescent bulbs in restrooms and hallways. Some of the older dorms, like Reid, have incandescent bulbs in the halls. About 15 years ago fluorescent bulbs were installed in Reid, but the students complained and the incandescent bulbs were put back. Students were not informed of the college's reasons for replacing the incandescent bulbs with fluorescent ones. With the present dorm renovations, fluorescent bulbs were proposed for student rooms. But the proposal was rejected by students and by administrators on the Renovations Committee based on aesthetic preferences. Many people dislike the color rendition of fluorescent bulbs. However, newly developed fluorescent bulbs have improved color rendition similar to incandescent bulbs (Kestner, U.S. Dept. of Energy).

Efficiency is measured by how many lumens (visible light) is produced per watt (unit of input power). The more light a source gives off for an amount of power, the more efficient it is. Incandescent bulbs are the most common and the least efficient. They waste 93-96% of their energy, giving it off as heat rather than light. They also have the shortest life span of all bulbs (about 1000 hours) and lose 20% of their original light output toward the end of their lives. Long-life incandescent bulbs have slightly lower efficiency and light output that regular ones.

Fluorescent bulbs are 3-7 times more efficient than incandescent ones and they last typically 10 times longer (over 10,000 hours). Straight fluorescent bulbs are more efficient than circular ones, while standard color ones are more efficient than the deluxe color ones. For a comparison of compact fluorescent bulbs, see Figure 2-1 and Table 2-1. Low-pressure sodium bulbs are the largest and most expensive, followed by high-pressure sodium bulbs (Duquesne Light, U.S. Dept. of Energy).

While the college has chosen the most efficient means of affordable lighting in most cases, improvements still can be made. Fluorescent bulbs could be installed in dorm rooms. Dimmers could be installed allowing light output to vary. They save energy and extend bulb life. Two-way "hi-low" switches also save energy, but lack the flexibility of dimmers. (Three-way bulbs are not very efficient). In rooms where incandescent bulbs are still used, the bulbs should be energy saving bulbs. Occupancy sensors - optical, ultrasonic, or infrared - are another option. They switch lights on when they detect a person and off when no one is there. They are expensive at present and would serve best in the dorm parlors where space occupancy is not predictable (LILCO, USDOE).

Figure 2-1

**Light Bulb Cost Comparisons**

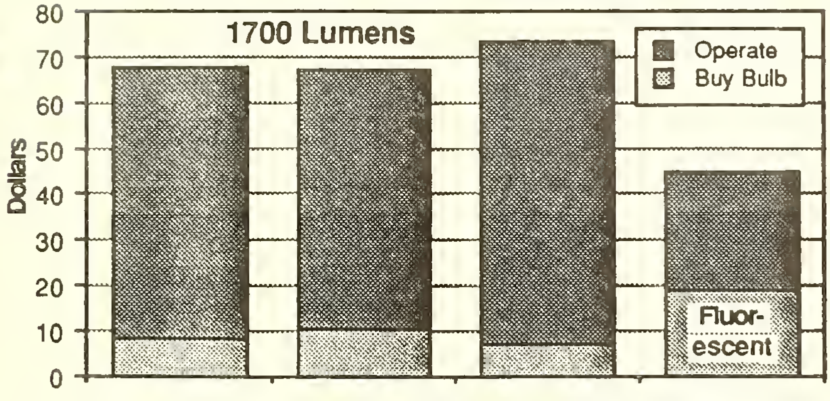
**Compact Fluorescents vs. Incandescents**

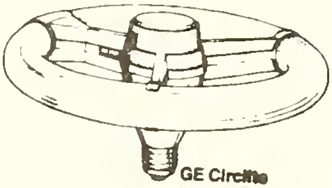
**10,000 Hours of Use**

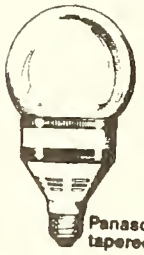
**Electricity at 6 ¢/kWh** Sales Tax at 4.5%

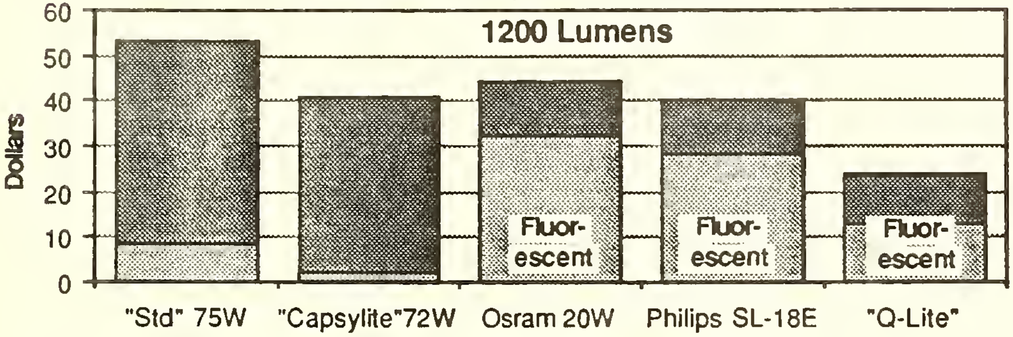
Costs Adjusted for Minor Differences in Light Output (Lumens)

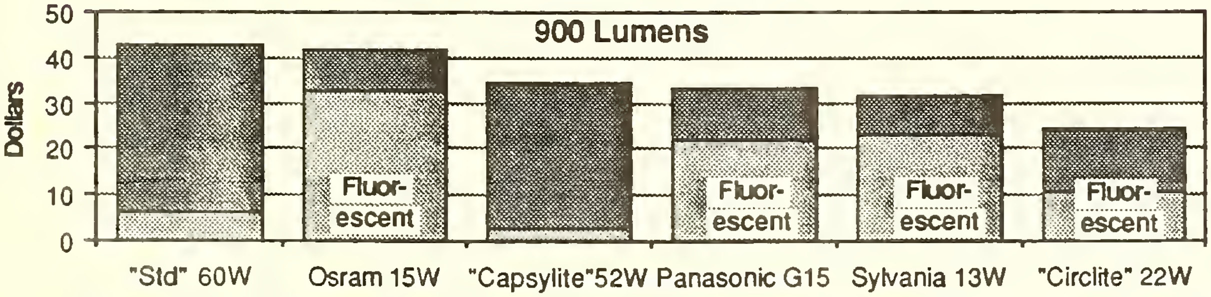
All light bulbs shown to the same scale.

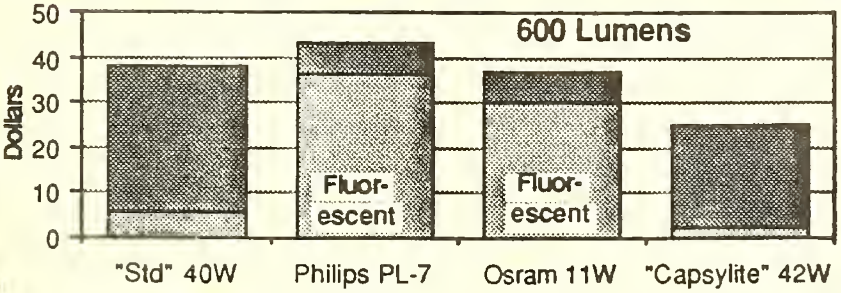


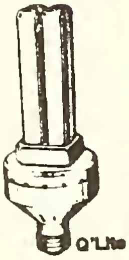












**Notes:** Sylvania compact fluorescents are available thru Interstate Electric Supply in Lynchburg.

An example of adjustment to compensate for differing lumens: the 900 Lumen Osram 15 Watt bulb was not adjusted at all, but costs for the 860 Lumen,13 Watt Sylvania bulb were multiplied by 900/860.

Operation costs do not include air conditioning to remove heat generated by lights. Fluorescents generate much less heat.

Price of "Capsylite" was subsidized by Central Maine Power Co.

Osram is in Montgomery NY, near Albany. Tek-Tron was in LaHabra CA, Q-Lites in Walnut CA, and Lites of America in Industry CA. Q-Lites and LOA are no longer there. Try NYC for Panasonic and Mitsubishi.

## Table 2-1. Light Bulb Comparisons: Compact Fluorescent vs. Incandescent

|  | Ballast |  | Bulb |  |  |  | Lumens | Life | Shade of | Wide | Long | Wt. | Flicker | Retail |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Shape | Maker | Model | Maker | Model | Lumens | Watts | /Watt | (Hrs) | White | (in.) | (in.) | (oz.) | (sec.) | Price |
| **COMPACT FLUORESCENT LIGHT BULBS** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 2 U-tube | Osram |  |  | integral | 1200 | 20 | 60 | 10K | yellowish | 2.2 | 7.9 | 5 | 1 | $31.00 |
| ‡ 4-tube | Q-Lite | 2004 | Lites of America | FDL18LE | ~1170 | 18 | ~65 | 10K* | " | 2.8 | 7.25 | 6 | 1 | 11.99 |
| 2 U-tube | Osram |  |  | integral | 900 | 15 | 60 | 10K | " | 2.2 | 6.65 | 4.5 | 1 | 31.00 |
| 2 U-tube | GTE | A-013 | Sylvania | F13DTT/27K | 860 | 13 | 66 | " | yellow-orange | 2.45 | 7.6 | 15.5 | 3 | 20.18 |
| 2 U-tube | Tek-Tron | 10013 | Philips | PLC13W/27 | " | " | " | ~9K | " | 2.2 | 6.2 | 13 | 2 | -- |
| 2 U-tube | Osram |  |  | integral | 600 | 11 | 55 | 10K | yellowish | " | 5.4 | 4 | 1 | 29.00 |
| 1 U-tube | GTE | A-579 | Sylvania | F9TT/27K | " | 9 | 67 | " | yellowish? | 2.45 | 7.5 | 15 | ? | -- |
| 1 U-tube | GTE | A-579 | Sylvania | F7TT/27K | 400 | 7 | 57 | " | " | " | 7 | 14.5 | ? | -- |
| 1U-tube | Philips | PL-7? | Philips? | PL-7? | ~380 | " | ~54 | ~9K | bluish | 1.4 | " | 12? | 2 | 19.95 |
| barrel,clear | Philips | SL-18: Electronic |  | 1 3-U tube | 1100 | 18 | 61 | 10K | orange-green | 2.7 | " | 7 | 0† | 25.00 |
| barrel | Litetronic | Lux PAQ17 | ? | ? | ~800 | 17 | ~47 | ~9K | ? | 3 | " | 15 | ? | -- |
| barrel,clear | Philips | SL-18:Magnetic |  | 1 3-U tube | 750 | 18 | 42 | 9K | yellow-orange | 2.7 | 5.6 | 18 | 2 | -- |
| ‡ barrel | Mitsubishi | Marathon T15L |  | integral | 720 | 15 | 48 | 10K | yellow-green | 3.0 | 6.6 | 17 | 2 | 13.00 |
| barrel | Panasonic | BFT15LE-T |  | " | " | " | " | 9K | yellowish | 2.9 | 6.85 | 15.3 | 3 | 15.00 |
| ‡ globe | Mitsubishi | Marathon G15L |  | " | " | " | " | 10K | yellow-green | 4.1 | 6.7 | 17 | 3 | 13.00 |
| globe | Panasonic | G15 |  | " | ~720 | " | ~48 | 9K | yellowish? | 3.6 | " | 15.3 | ? | 15.00? |
| donut | GE | FCB700/1 | "Circlite" | FCS10/SW | ~1750 | 44 | ~40 | 10K | plain | 9.9 | 4.9 | 32 | 2 - ∞ | 18.98 |
| donut | Sylvania | ? | "Circlite" | ? | 1150 | 22 | 52 | 12K | ? | 9? | 5? | ? | ? | -- |
| donut | GE | FCB400 | "Circlite" | FC89T | 870 | 22 | ~40 | 10K | bluish | 8.4 | 4.8 | 21 | 3 | 9.88 |
| ? | GE | Compax |  |  | ~800 | 15 | ~53 | ~9K | ? | ? | ? | ? | ? | -- |
| **INCANDESCENT LIGHT BULBS** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| cone-globe | GE, Philips, Sylvania |  |  | standard | 1710 | 100 | 17 | .75 K | yellow-orange | 2.2 | 4.2 | 1.1 | 0 | .60 |
| " |  |  | GE | miser | 1710 | 95 | 18 | " | " | " | " | " | " | .75 |
| " |  |  | most | long life | 1630 | 100 | 16 | 1.1 K | " | " | " | " | " | .63 |
| cone-reverse cone, flat top "Capsylite" |  |  | Sylvania | (halogen) | 1300 | 72 | 18 | 3.5 K | " | " | " | 5.5 | " | .83 |
| cone-barrel |  |  | Philips | standard | 1220 | 75 | 16+ | .75 K | " | " | " | 1.1 | " | .59 |
| cone-globe |  |  | GE | " | 1170 | 75 | 16- | " | " | " | " | " | " | .60 |
| " |  |  | Philips | " | 890 | 60 | 15 | 1.0 K | " | " | " | " | " | .59 |
|  |  | (halogen) | Sylvania | "Capsylite" | 885 | 52 | 17 | 3.5 K | " | " | " | 5.5 | " | .83 |
| cone-globe |  |  | " | standard | 870 | 60 | 14.5 | 1.05 K | " | " | " | 1.1 | " | .62 |
| " |  |  | GE | " | 855 | 60 | 14 | 1.0 K | " | " | " | " | " | .60 |
|  |  | (halogen) | Sylvania | "Capsylite" | 665 | 42 | 16 | 3.5 K | " | " | " | 5.5 | " | .83 |
| cone-globe |  |  | GE, Philips | standard | 490 | 40 | 12 | 1.0 K | " | " | " | 1.1 | " | .60 |
|  |  |  | Sylvania | " | 445 | 40 | 11 | 1.57 K | " | " | " " " |  | " | .62 |

**NOTES:** Compact fluorescent bulbs burn out (smoking up the house) at once on dimmer circuits. They burn out soon (50-2000 hours) if fully enclosed.

* = ballast burns out in minutes, if adequate heat ventilation is not provided (e.g., several inches to ceiling), especially with more than 1 bulb in fixture.

‡ = probably no longer available in the U.S.

† = no flicker. Light level increases rapidly for 2 seconds, then slowly for 5 minutes more.

Much energy is wasted not only by inefficient light sources, but also by human energy-consuming behaviors. A powerful motivational force for energy conservation is lost on college campuses and other places where the consumers do not directly pay for their utilities. Yet, students should keep in mind that they pay for these costs indirectly in ways like tuition increases. It does pay to save energy. The most common waste of energy is when students leave lights on in rooms when they leave. This is especially true of lights left on late at night, when the light will probably not be turned off until morning. Students sometimes turn on several lamps in parlors rather than one larger overhead light. They often leave on lights in restrooms, followed by television rooms and kitchens. The hours from noon until 6 p.m. harbor the most waste, based on a four week pilot study in the Language House and a one week pilot in Randolph, Grammer, Meta Glass, and Reid. One of the study's hopes is that students will be more aware of this waste, remember to turn off lights and conserve energy themselves, and encourage others to do the same. It only takes a small amount of effort on each person's part. (See pilot studies of electricity use in dorms in Appendices A-1 and A-2.)

## Source of Electricity at Sweet Briar

Sweet Briar College receives its electricity from the Appalachian Power Company, which generates peaking power at the Smith Mountain and Leesville dams. Construction on these dams began in 1960 and was completed in 1962, costing more than $66 million. Smith Mountain Lake was completely filled in 1966. Water passes through turbine generators at the Smith Mountain Dam to produce electricity and is caught and stored at the Leesville Dam 17 miles downstream during periods of peak demand like the weekdays. At other times when the demand is lower, the water is pumped back up into Smith Mountain Lake by steam-electric generators, for re-use. A portion of the water at the Leesville Dam passes through turbine-generators there to produce electricity a second time. This pumped storage method allows steam-electric plants to operate more efficiently, because they do not have to reduce their workloads during periods of low demand. The Smith Mountain Dam generates 444,000 kilowatts, seven times what the normal river flow could produce.

Dam construction spurred economic growth in the area by bringing in manufacturers and mining companies, and by creating jobs. Appalachian owns 5,000 acres of woodlands which have been turned into a wildlife management area by the Department of Game and Inland Fisheries. Smith Mountain Lake is regularly stocked with fish, especially trout. There are many recreational activities at the lake, including hiking, boating and camping. The dams have also contributed to flood control in the area. The

Smith Mountain Dam can store flood waters; there is a communications network between localities, industries, marina operators and the dams to warn of impending flood conditions (Visitors Center at Smith Mountain Dam).

On the other hand, fluctuation of the water levels is 13 feet. This has produced visible mud flats and erosion. In addition, there have been no long-term comprehensive studies of this dam's effects on the ecosystem. Research is needed since it is well-known that dams can have harmful consequences as well as beneficial ones. Problems of salt buildup, siltation and succession may occur. Animal and plant population explosions can lead to overcrowding and competition that eventually deplete the number of organisms.

Electric generation relies primarily on coal for its fuel, comprising nationally 55.4% of the total fuel sources. Gas provides 9.5%, hydro power 9.5%, nuclear power 18.9%, oil 5.7%, and other sources .7%. (USDOE [1990], corrected for wood-electric omission) Coal, natural gas, oil, and uranium are non-renewable resources. We know that the supplies are finite. It is imperative that we increase our energy efficiency to extend these supplies. This would allow us to phase in renewable resources suited for particular localities and regions. In addition, the environmental impact of each alternative should be considered when deciding which combination of alternatives should be used in a given area (CED 33, Miller 341-2).

## Potential Renewable Resources for Electric Generation

Some renewable resource alternatives are solar, water , wind and biomass. Solar energy may be feasible at the college sometime in the near future. It can be used for heating and cooling buildings and generating electric power. Passive or active systems may be used to gather solar energy. Some of the technologies are well-developed and cost-effective on a lifetime-cost basis. Their energy yield is moderately high. Carbon dioxide and other air and water pollutants are not released. Because the energy supply is unavailable at night and during periods of cloud-cover, it is necessary to have heat storage or back-up heating systems. Initial installation costs are high (Macrakis 540, Miller 398-9).

Direct solar energy could be concentrated to produce high-temperature heat for producing electricity in a solar power plant, but the costs are still high. Photovoltaic cells convert energy into electricity directly, with minimal environmental impact. While the costs are still high, they are expected to become more competitive in the next ten years. Solar energy could very well be feasible in Virginia and at Sweet Briar College in the near future. Sunlight is available in Virginia 70-80% of the day, which is considered good (Miller 419). In addition, continued use of the Smith Mountain and Leesville dams, already discussed, is desirable. Hydroelectric power plants are the cheapest source of electricity . Their efficiency is 83-93% and they produce full power 95% of the time, while lasting two to ten times as long as coal and nuclear plants. However, more research needs to be done to investigate the impact of the dams on the environment and the ways in which these effects can be minimized (Miller 403).

Additional renewable alternatives mentioned above but not discussed in this paper may not be feasible or cost effective at the present; but these alternatives should not be overlooked. As technologies improve and production is increased, these alternatives may prove to be more desirable, applicable, and affordable. Of course, all alternatives are going to involve trade-offs. It should be remembered that the best overall alternative is to reduce energy waste by reducing its consumption (raising end-use efficiency). Heavy reliance on non-renewable resources should be replaced by a more diversified reliance on a combination of renewable energy alternatives (Miller 413).

## Energy Regulation

The Federal Energy Regulatory Commission regulates interstate transmission and sale of electricity and natural gas. Activities involving nuclear generated electricity come under the Nuclear Regulatory Commission. The Federal Energy Administration deals with petroleum products. Many corporations, these agencies, and a host of other federal, state and local agencies manage U.S. energy resources and policies. Quick and efficient information dissemination among researchers, producers and consumers is needed. Most agencies need more funding and improved communication networks if the U.S. is to have a viable and environmentally sound long-term energy management program that outlines future goals and alternatives. Such a program should identify and address important issues, and monitor energy resources. The general public and people in the government should be educated about production and use of energy (Ruedisili 516-7).

## Environmental Impacts of Different Energy Sources

Energy production relates to other resources and environmental problems. Plants that generate electricity by burning fossil fuels like coal contribute to air pollution through emissions of sulfur oxides and other pollutants (which result chiefly from impurities in the fuels). Burning these fuels also increases the levels of carbon dioxide. These are contributors to the "greenhouse effect" (Chapter 3) and "acid rain". Steam power plants that operate at 33% efficiency waste two units of heat for every one unit they convert to electricity.

Oil, in addition to air pollution problems, can be toxic when spilled or dumped into the ocean. Estimated total oil influx into the oceans is 5 to 10 million tons per year. Coal is usually strip mined, a process that causes land and ecosystem destruction and degradation. Stream siltation from erosion and run-off can result (Ruedisili 132, 138).

Nuclear power plants generate waste, some of it radioactive for hundreds and thousands of years. Most of it is stored on site in containers in pools. If precautionary and safety measures are followed, the actual risk to humans or the environment remains small. Yet, a greater potential risk remains for millenia (Ruedisili 74-6).

While solar energy has a good low energy input to energy output ratio, it too has environmental impacts. Use of land area and structural materials (steel and concrete) are high compared to coal and nuclear technologies. Manufacture of photovoltaic units requires use of toxic chemicals (e.g., cadmium sulfide and gallium arsenide). Wind power has few adverse environmental impacts, but wind machines should not be located near flyways. Disruption of natural aquatic ecosystems by dam construction was mentioned previously. Soil erosion, nutrient loss, water runoff, water quality degradation, loss of fish and wildlife habitat, competition with food and fish production, and air pollution from combustion can result from use of biomass forms of energy (Pimentel et al. 70-73). "There is no free lunch."

## The Future

Electricity generation depends on other resources. In a century of electric generation, different resources have been used to varying degrees. The primary resources have been non-renewable. The supply of these resources is finite, a fact largely ignored until the energy crisis in the mid-1970s forced people to re-evaluate their energy choices. We now need to conserve our energy through better efficiency and less consumption. We need to invest in alternative renewable resources that meet our requirements in a particular area. We need a comprehensive national management program and better communications networks.

At Sweet Briar College we also need to be energy efficient and look into viable energy alternatives. The college tries for energy efficiency within economic constraints. Capital input is inevitably linked to trade-offs and return on investment. Students can contribute to energy conservation with better behavioral patterns. Using electricity properly and efficiently helps alleviate unnecessary waste and expense. The college has the opportunity and responsibility to educate its community about energy production and use. Energy conservation is everyone's responsibility. Together, we can improve our community and make the world a better place for ourselves and future generations.

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# PART 2

## THERE IS NO SUCH THING AS "AWAY."

Solar energy in its broadest context, geothermal energy, and nuclear energy inputs into the Earth's system drive the continuous transformations that collectively form "cycles of matter." The most well-known of these cycles, the nitrogen, carbon, and water cycles, illustrate how matter changes forms among the atmosphere, hydrosphere, and lithosphere. Consider the path of a water molecule: falling down a waterfall; losing velocity as the stream slows and widens into a river; diverted into an irrigation canal; sucked up through the roots of a corn plant; transpired into the atmosphere while some of its colleagues are transformed into glucose and eaten by cows; lifted into the upper atmosphere; cooled and condensed over the Arctic; transformed into ice capturing gaseous bubbles which are analyzed centuries later as intelligent life tries to determine the concentration of the greenhouse gases. Such paths as these weave together all forms of matter, living and nonliving. To learn of such complexities and interdependencies is to take steps down the road of holistic thinking.

In Part 2, human interactions with the atmosphere, hydrosphere, and lithosphere are addressed. The atmosphere has been polluted by transportation, electric utilities, industries, and biomass burning. The United States has established the Clean Air Act and regulated auto and industrial emissions. The Montreal Protocol has established regulation of CFC's, although many claim it is too little too late. The foci of the atmosphere section document are the much-acclaimed global warming and indoor pollution, prompted by research indicating that many of our pollutants have higher concentrations in our well-insulated, energy-saving homes than in ambient air. Smoking is one of the major contributors to indoor pollution. The impact of passive smoke has received considerable attention. A smoking survey investigates student attitudes toward smoking at Sweet Briar.

The hydrosphere (oceans, rivers, etc.) plays a powerful role through the hydrologic cycle. The importance of an adequate water supply and pure drinking water cannot be underestimated for the health and well-being of all communities of organisms. The chapter on water resources focuses on water treatment for pure drinking water and sewage treatment to prevent pollution of downstream waters. With the rise of the bottled water industry, one student chose to investigate student perceptions of Sweet Briar water's taste and student bottled drinking water consumption.

Air and water are perpetually reforming the land. The land types considered here are forests and agricultural lands. Forests generally function under multiple use management, and Sweet Briar is no exception. Sweet Briar forests are preserved as sanctuaries, used for recreational riding and hiking, and managed for wood production. Further, our community benefits from the ecological roles played by mature forests: transformation of carbon dioxide into oxygen (thus, relieving greenhouse gas buildup), erosion control, nutrient cycling, groundwater filter, and wildlife habitat. The agricultural lands of Sweet Briar, once highly diverse, now focus on the dairy operation. Crops are grown for the cattle. Soil erosion, soil nutrients, pesticide use, and water quality are all important concerns of the agricultural business.

Finally, this section addresses the issue of solid waste management. Most landfills will be closed by the year 2000. Sweet Briar currently uses a landfill, which will be closing shortly. Recycling and waste reduction efforts on campus help move Sweet Briar toward a more sustainable future and a new consciousness that "all cycles matter, and all matter recycles."

# CHAPTER 3.
# ATMOSPHERE: GLOBAL WARMING
by Jennifer Jarvis

## Introduction

Global warming is one of the main headlines in today's media. It is most often described in news reports as the "greenhouse effect." This name is used to illustrate how the heat-trapping gases (or trace gases) in the atmosphere act like a glass pane in a greenhouse. In other words, the greenhouse gases let the high-energy radiation from the sun enter the earth's atmosphere, but do not let the low-energy heat re-radiate back into space. This phenomenon creates a warming of the atmosphere. Human activity has not created the greenhouse effect of the earth; our activity has only increased the quantity of greenhouse gases and the rate of global warming.

The greenhouse effect needs to be in a certain balance in order for earth to be hospitable for life as it is now. One can look at the greenhouse effect as if it were on a scale. Without any greenhouse effect, Earth would be a cold and frozen planet with temperatures approximately 60°F (33°C) colder than now (Schneider 13). But, if Earth builds up too much of a greenhouse effect, temperatures on average would be too high for most life forms to exist on the planet. In other words, we humans must keep the scales of the greenhouse effect at a balance within a narrow temperature range. We must, at a minimum, work to keep the scales from tipping faster than nature can adapt.

But today's societies are not trying to keep this balance. Humans keep adding greenhouse gases to the atmosphere every day through burning of fossil fuels, slash-and-burn agriculture, other burning of biomass (living material such as trees,vegetation, or grasses), and tearing down tropical rain forests. As we keep adding more of these gases, we will see an increase in global average temperature. This will have tremendous effects around the globe by changing regional patterns of rainfall and temperature. This change in regional patterns will cause a huge disruption in today's established patterns of agriculture.

Obviously, global warming and the greenhouse effect must be addressed by policy makers, scientists, and citizens of every country. The main obstacle to implementation of better global warming policies, however, is that it cannot currently be proven "beyond a reasonable doubt" that the earth is already experiencing global warming. The scientific community faces many uncertainties when predicting the rate of global warming. But computer models do not come up with a common amount of average temperature increase for the next century. Nor do computer models come up with common regional temperature and rainfall variations. However, their disagreements are due almost entirely to differences in treatment of cloud effects. According to the Natural Resources Defense Council, "the best of the present climate models show that if atmospheric carbon dioxide ($CO_2$)were to double, the average global temperature would rise between 3.5 and 4.5 degrees C. By way of comparison, the typical natural variation of mean global temperatures over periods of 100-200 years has been at most 0.5 to 1 degree C.--smaller that the expected rise in mean global temperature for doubled $CO_2$ by at least a factor of 4." (Abrahamson 9). James Hansen of the Goddard Institute of Space Studies at Columbia presented data to the U.S. Senate Committee on Energy and Natural Resources on June 31, 1988 which reported that "the earth had warmed between 0.5 and 0.7 degrees C. over the past century and that the warming is accelerating." (Abrahamson 76). It is almost certain that, as the globe's temperature increases, ocean levels will rise and regional rainfall and temperature patterns will change.

Since the scientific community disagrees about factors in the greenhouse effect, policy makers generally wait for definite greenhouse effect experience. This type of policy-making concerning global warming should be changed because if we wait until the greenhouse effect is upon us, we will really not be able to do anything about it. One quote to keep in mind when thinking about the problem of all the uncertainties of the greenhouse effect is from Stephen Schneider, a climatologist with the National Center for Atmospheric Research, "How much and how fast temperatures will change and how these changes will alter accustomed patterns of rainfall, drought, growing seasons, sea level, and so on is controversial. But the greenhouse effect as a scientific proposition is as widely accepted a theory as there is in the earth sciences today" (Schneider 13).

## Contributors to the Greenhouse Effect

Five main gases in the earth's atmosphere are considered greenhouse gases. They are water vapor, carbon dioxide, methane, nitrogen oxides, and chlorofluorocarbons (CFC's). About fifteen additional greenhouse gases have been identified. Many of the gases classified as "greenhouse gases" would not normally be thought of as air pollutants. Carbon dioxide, for instance, is not considered a pollutant, except when concentrations are abnormally high.

The major anthropogenic contributor to the greenhouse effect is carbon dioxide. According to Stephen Schneider, "Carbon dioxide is dumped into the atmosphere at a much faster rate than it can be withdrawn or absorbed by the oceans or living things in the biosphere. Carbon dioxide buildup in the next few decades to centuries could well be one of the principal controlling factors of the near-future climate" (Schneider 21). Currently, scientists see an annual .4% increase in$CO_2$ levels. This may seem very small, but added to the amount already there, it compounds to become significant. Burning fossil fuels, especially oil and coal, is the major source of $CO_2$ in the atmosphere. Some scientists say "the impetus behind global warming is so great that even drastic reductions in the burning of fossil fuels will not halt the trend from occurring. They also warn that without strong measures to decrease fossil fuel combustion, changes could come upon us so suddenly and drastically that society might suffer a virtual breakdown" (Null 6). This statement conjures up some scary thoughts for today's society when it comes to the use of fossil fuels. Not only could we be faced with heavy damage from the greenhouse effect, but we could be without the energy from fossil fuel combustion. Right now we have not installed the technology to support society's energy consumption without extensive use of fossil fuels. More research and development needs to be done in alternative energy such as solar or wind power, requiring more money for such programs. Many experts predict that as we run low on fossil fuels, renewable energy will still be underdeveloped. Consequentyly, society will by default turn to nuclear energy, which has clear advantages (e.g., no $CO_2$ emissions), but also some very definite disadvantages (e.g., radioactive waste).

Another problem in controlling fossil fuel combustion is that many developing countries plan to use coal as a base for their economic growth. China, for instance, has planned its economic growth and development on the basis of its large coal reserves. Unfortunately, coal is the fossil fuel that releases the greatest amount of $CO_2$. International policies and pressures come into play in this case. Many developed countries point fingers at developing nations that plan to use coal to rise out of poverty. But developed countries themselves used coal as their main energy source during their developing years. What gives these developed countries the right to say anything to the developing countries that still have to pay their debts to the developed countries? Many developed countries still use coal and often produce pollution in larger amounts or in more toxic concentrations than developing nations.

Issues involving the use of coal in developing countries are similar to issues involving the world's tropical forests, especially the Amazon. Not only did developed nations participate in slash-and-burn agricultural practices during their developing years, but they also cut down timber for the same reasons that the developing nations are. Yet these developed countries object as the developing countries chop down their own forests. In the case of the Amazon forest, there is a very ironic twist. Some U.S. citizens insist that South America stop cutting their trees, but the U.S. citizens keep buying products created by cutting trees. For example, U.S. companies buy beef from slash-and-burn fields in the Amazon forest. An article published by U.S. News and World Report stated that, "Some 138 million pounds of beef were imported from Central America last year (1987)" (Allman 68). The article also stated that 55 square feet of grazing land of tropical rain forest is needed for aquarter pound of beef. Clearing that 55 square feet caused a quarter ton of $CO_2$ emissions. Now, think of all the hamburgs you ate last year. Where did that beef come from? How much pollution was created for each of those juicy hamburgers?

Since trees convert carbon dioxide to oxygen, chopping down trees is one contributor to the greenhouse effect. Burning chopped trees and the surrounding vegetation compounds that effect. Plants, especially trees, take in a large amount of $CO_2$ each year through photosynthesis. According to George M. Woodwell, "The annual absorption of carbon by plants globally through photosynthesis is about one hundred billion tons, approximately one-seventh of the atmospheric burden. There is an approximately equal release of carbon from the biota and soils into the atmosphere through respiration. Any factor that affects this exchange, either the photosynthetic absorption or the release through respiration, has the potential for affecting the amount of carbon in the atmosphere significantly" (Abrahamson 77). In other words, as humans start cutting and burning large forest tracts, they disturb the natural balance between photosynthesis and respiration. A larger amount of $CO_2$ enters the atmosphere than when the trees remained standing.

Slash-and-burn management is the strategy most often used to transform forests into agricultural land. At the present time, this type of agriculture is most often found in developing countries, particularly in the Amazon Rain Forest region. In slash-and-burn agriculture, a farmer cuts down many of the trees in the new farm site. When the timber and vegetation dries out, the farmer, often with the aid of gasoline or kerosene, burns the whole area. Ash from the burn is mixed with the soil as fertilizer for planted crops. Ironically, in those lands, the soil only stays fertile for a couple of years. Then it is useless for farming or grazing.

Research in the last five years shows that burning of biomass creates many greenhouse gases, including $CO_2$. "According to American and Brazilian scientists monitoring the Amazon, they (fires) are so numerous and the destruction so widespread that these annual burning rituals may be accounting for as much as ten percent of the global man-made output of carbon dioxide" (Null 7). Many of such rituals are the traditional method of farming by many South American tribes. The amount of $CO_2$ emitted to the atmosphere through biomass burning is astounding. George M. Woodwell stated in his article, "Biotic Causes and Effects of the Disruption of the Global

Carbon Cycle," that, "Current estimates are that net releases from deforestation globally is one to three billion tons annually. That release is to be compared with the nearly six billion tons of carbon released through the combustion of fossil fuels." Only five percent of biomass burning is caused naturally by such events as lighting. In a report issued by the Space Research Center in Sao Jose Dos Campos, the following was stated, "the fires (Amazon) in 1987 alone produced $CO_2$ containing more than 500 tons of carbon, 44 million tons of carbon dioxide, more than six million tons of ozone and more than one million tons of nitrogen oxides and other substances that can circulate globally and influence radiation and climate" (Null 7).

Chlorofluorocarbons (CFC's) form one class of man-made pollutants that contribute to global warming. Never have CFC's been found occurring in nature. About fifty years ago, industry introduced this new wonder chemical that had many great uses. The new CFC's were used in aerosols, insulation, styrofoam, coolants for air conditioners and refrigerators, foaming agents, and, more recently, cleaning agents. But, in the mid-1970's two scientists discovered that this miracle chemical was also good at another unexpected thing, destroying the earth's ozone layer in the stratosphere. In fact, it has been found that a single molecule of CFC can destroy tens of thousands of ozone molecules. The earth's ozone layer keeps most harmful ultraviolet rays from entering the atmosphere. If ultraviolet rays reach living things, the radiation can damage living cells by breaking down DNA. Solar ultraviolet radiation can cause sunburn and some forms of skin cancer in humans. Numerous experts have reported that for each one percent decrease in ozone in the stratospheric layer of the earth's atmosphere, skin cancer could increase four to six percent. William Walsh, a staff attorney for the U.S. Public Interest Research Group, claimed that, "If we saw a decrease of the ozone layer of seventy percent, for example, for a Caucasian to go out into the sun would result in blistering sunburn after only ten minutes of exposure. If there was a fifty percent decrease, a Caucasian would have about an hour in temperate climates before he or she would experience a sunburn to the point of blistering. Even with only a twenty-five to thirty percent decrease in the ozone, outdoor work such as farming, fishing, and building would be virtually impossible because of the risk of sunburn and resultant skin cancer" (Null 22).

Besides destroying the upper ozone level, NASA researchers report that CFC's contribute approximately 20% to the greenhouse effect. It has been found that some types of CFC's can have up to 10,000 times the heat-holding capacity of carbon dioxide. CFC's are increasing in the atmosphere at an annual rate of five percent. Thus, CFC's emissions should be closely watched by policy makers, scientists, and citizens of every country. In its October 31, 1988 article by William F. Allman, U.S. News and World Report quoted that, "There are an estimated 90 to 95 million auto air conditioners in use in the U.S." (Allman 68). Allman also said that installed auto air conditioners emit about 2.5 pounds of CFC's and that an annual recharge of an air conditioner emits about one pound of CFC's. Refrigerators and freezers also utilize CFC's. Many home or business refrigerators leak CFC's from their coolant systems. And all the old refrigerators and freezers that are put into our landfills every year leak a large amount of CFC's as they sit there or are bulldozed over.

Another greenhouse gas is methane. According to George M. Woodwell, "The influence of carbon dioxide and methane dominate because these gases are the most abundant of the heat-trapping trace gases, and their concentrations are accumulating rapidly. Methane is disproportionately important because its absorption band in the infrared is otherwise unobstructed and a small change in the amount of methane brings a large change in temperature" (Abrahamson 74). Since the 1800s, there has been an increase of almost 100% in the amount of methane in the atmosphere. Samples from ice cores in the Antarctic show strong correlations between atmospheric temperature and atmospheric methane concentrations as measured in trapped air bubbles (Schneider, Global 40). But, it has also been documented that most methane production appears to come from agricultural actions rather than industrial actions. Decomposition, wet rice paddies, and a cow's digestive track all produce methane. So does biomass burning. Fossil fuels also contribute some to the increase in methane levels. "Some methane releases result from venting from oil and gas fields, leaks from gas distribution systems, and the outgassing of coal mines. With a fifty percent reduction in fossil fuel use, methane emissions would decline by five to ten percent" (Abrahamson 28). There is a positive feedback loop between global warming and methane. "It must not be forgotten that global warming itself will increase atmospheric emission of carbon dioxide and methane from biotic and marine carbon pools" (Abrahamson 31).

The fourth class of greenhouse gases is nitrogen oxides. The U.S. has only 5% of Earth's population, yet releases 26% of the world's nitrogen oxides (Linden 63). Nitrogen oxides have 250 times the heat trapping capacity of carbon dioxide. Not only are nitrogen oxides a greenhouse gas, but they are also a main component of acid rain. One source of nitrogen oxides is fossil fuel combustion. But, biomass burning accounts for almost a fourth of the total amount of nitrogen oxides. A small amount is produced naturally from the soil and from lightning.

Water vapor is a natural greenhouse gas over which humans have virtually no control. Some regions will experience more rainfall; others will experience droughts. In essence, the same amount of water vapor should always be in the atmosphere.

In contrast to the radiation filtering protection offered to humans by stratospheric ozone, tropospheric ozone, has the potential to be an important greenhouse gas. It is a secondary pollutant photochemically produced from the pollutants of fossil fuel combustion.

## Effects of Global Warming

There are uncertainties which limit our understanding of the potential effects of global warming. We lack knowledge about the types of negative and positive feedback loops that may develop. In particular, we do not completely understand the role that high and low clouds or the ocean will play. We also have incomplete knowledge about how periods of sunspots effect global temperature (Schneider, On Global Warming Conference).

In spite of these caveats, "a draft report prepared by the normally cautious Environmental Protection Agency in October of 1988, the predictions of chaos and disaster were unprecedented" (Null 5). Such predictions regarding global warming are commonplace. Statements are given on how global warming will effect things such as the oceans, tree populations, severe weather, and food security. The EPA concludes, "Global climate change will have significant implications for natural ecosystems; for when, where, and how we farm; for the availability of water to drink and water to run our factories; for how we live in our cities; for the wetlands that spawn our fish; for the beaches we use for recreation; and for all levels of government and industry" (Null 5).

As global temperatures rise, so will the ocean. In 1988, an EPA study found that, "man-made global warming could flood an area of the United States coastline the size of Massachusetts..." (Allman 58). Some claim oceans will rise about six feet, as the ocean water expands due to the warming and as ice sheets and glaciers melt. According to the Union of Concerned Scientists, “Analyses suggest that the sea level rise will be between one and three feet by the mid-twenty-first century, enough to cause severe coastal erosion, destroying irreplaceable wetlands, and contaminate water supplies and drainage systems with sea water.” (Union of Concerned Scientists). Places that are currently near sea level or below, such as New Orleans and the Florida keys, will be flooded.

The oceans also play another role in predictions and evidence. One significant phenomenon is the ocean thermal delay. It takes the oceans longer to warm than the atmosphere. A delay is usually at least a decade to perhaps half a century from the input of the greenhouse gases until the full effect of the warming can be measured. And, as a rule of thumb, the more greenhouse gases emitted, the longer the delay will be. Consider an analogy: compare cooking a stuffed turkey with an unstuffed turkey. They are both put into ovens of the same temperature and allowed to cook for the same amount of time. But, when they are taken out of the oven, the stuffed turkey will not be as cooked as the unstuffed turkey. The stuffing is a cooler mass that can only be heated slowly since it takes the heat a while to penetrate to the core of the stuffing. The stuffed turkey is similar to our planet as it undergoes global warming with the stuffing being the ocean.

"A warmer world will be a wetter world, too, as evaporation increases with the temperature and what goes up must come down." (Abrahamson 13). Distribution is not likely to be even. Some parts of the world could experience heavy flooding, while elsewhere, the land is suffering from severe drought. Some predictions say that, "Even a few degrees change in the average temperature of the planet could make Iowa a desert and Alberta a breadbasket..." (Allman 58). In both the sense of rainfall and changing temperatures, some economic activities such as agriculture will be greatly affected by the greenhouse effect.

Further, "Global warming will increase the frequencies of extreme weather events" (Abrahamson 12). According to a pamphlet by the Union of Concerned Scientists, "... as the oceans warm, the severity and frequency of tropical storms and hurricanes are likely to increase." Hurricanes will be more frequent and hit coastal areas harder with an extremely low pressure center.

Another effect of global warming is the extinction of species, especially forest species. Several experts are reporting that each one degree C. increase in global temperature will cause a shift in temperate zones by about 100-150 kilometers north. The trees will not be able to migrate fast enough to keep up with the increase in temperature. By the time a tree is mature enough to send off its seeds, the soil is not appropriate for the seedlings so they either die or never even attempt to grow. "We thus could be headed toward a country almost devoid of young trees, a country given over to shrubs that tolerate a wide range of conditions - a sumac world." (Abrahamson 5). "Good-bye, Weeping willows; hello, Sumac shrubs."

Another set of concerns have to do with politics rather than science. Some reports suggest that if we do nothing to slow the greenhouse effect, the earth could be committed to a warming of eight degrees F. in forty years. "Global climate change is the central environmental problem of our time, and it is a situation in which there will be no winners" (Abrahamson 31). What happens to food security if agriculture patterns change due to global warming? What happens to national security when food security is altered? More policy makers are trying to deal with these questions. There are many predictions that the main agricultural area of the U.S., the Midwest, will become a desert leaving the United States with little food security and lots of unemployed people. At the Toronto Conference, they said, "Currently, levels of global food security are inadequate but even those will be most difficult to maintain into the future, given projected agricultural production levels and population and income growth rates. The climate changes envisaged will aggravate the problem of uncertainty in food security" (Abrahamson 50).

Faced with these catastrophic possibilities, uncertain as they are, we as citizens have choices to make. Some will choose to ignore or discount the building evidence and wait until global warming is a certainty and winners and losers more clearly defined before acting. Waiting, however, exacerbates the problem and makes it difficult, if not impossible, to do anything about it at a later time. It makes more sense to consider our own contributions to global warming now. We can then take preventative steps which will slow down the changes and make our adaptation (as well as that of other species) easier in the long run. We have an opportunity to act locally and globally simultaneously.

## Sweet Briar College and Its Contributions to Global Warming: Past, Present, and Future

The major contributors to global warming are fossil fuel combustion and biomass burning along with other agricultural practices. CFC's contribute to the greenhouse effect and destroy upper level ozone. Generally, citizens recognize contributions to global warming via cars and refrigerators, but most don't realize the role burning and other agricultural practices play, especially here on campus. It's one of the continuing illustrations of interconnectedness of all living things.

First, let's look at fossil fuel combustion which originates from both stationary and mobile sources. Stationary sources include power plants, utilities, and, for us on campus, the physical plant. This study looks only at the physical plant. Mobile sources include cars and the mass transit system. This study deals with individual transportation, mass transit on campus, some mass transit off campus, and the college owned vehicles.

Historically, the physical plant supplied the college with both electricity and steam. When the school was founded, fires were lit at seven in the morning in order to make electricity and steam. At ten o'clock at night, all the fires were banked until morning, leaving the college in a state of blackness (or candlelight). Electricity was generated by a steam engine. It is most likely that the physical plant used coal to produce energy and steam. Somewhere in the 1930s, the college switched to outside power. For the last couple of decades, the physical plant provides only steam. Now electric power is bought from Appalachian Power. Steam is used in the kitchen plus in the buildings as heat. The physical plant burns approximately 1800 to 2000 tons of coal during a school year with a "typical" winter. It is worth considering how much our winters and average temperatures might change in this region of the United States.

Sweet Briar currently has a single retort underfeed boiler with a multicylinder separator. As mentioned in Chapter 1, this is one of the cleanest methods of burning coal. To add to this already "clean" method of burning coal, the college uses a mix of stoker coal (which is an extremely clean burning type for coal) and sawdust from some of the local sawmills. By adding sawdust to coal, less coal is needed to produce the same amount of heat which means less pollution. In terms of pollution for smoke stacks, our physical plant always meets up to EPA requirements. Sulfur rather than carbon dioxide is the most important air pollution concern for Sweet Briar stacks.

There are four main options which could cut the physical plant's contributions to global warming: conservation, switch to natural gas, switch to renewable resource, or remove greenhouse gases from emissions. The first option is to conserve heat. If there is less combustion, there is less pollution. Heat can be conserved by keeping windows and doors shut during cold weather and not overheating a room. Solar heat supplement can be maximized in a room by opening drapes on a window during prime hours of sun and closing them at night.

A second alternative is substituting natural gas for the coal and sawdust. The physical plant has a boiler that is set up to burn natural gas. According to a fact sheet about global warming by Earth Day 1990, "It is important to note that burning natural gas releases seventy percent as much carbon dioxide per unit of energy as oil, and half that of coal" (Speth). But, the problem right now is that it is very expensive and not readily available to our college. When looked through an economic lens, our physical plant is environmentally friendly. (See Chapter 1.)

Third, the ultimate switch could be from coal to a renewable resource. An excellent, non-polluting way of producing steam is solar heating. The limitations of this strategy were discussed in Chapter 1.

A fourth option is to remove all greenhouse gases from the flue gases before they enter the atmosphere. The flue gases are the gases resulting from the burning of the coal in the boiler that escape through the smoke stack. Currently, flue gases go through a multicyclinder separator, which removes some particulates, before allowing gas escape through the stack. Sweet Briar does not have any type of scrubber in the smoke stack. Scrubbers are very expensive to install, making this option economically infeasible. A further concern is the scrubber's sludge, which could potentially pollute landfills and water sources.

The second type of fossil fuel combustion is mobile. This includes all types of mass transit and individual transit. The college owns and operates all mass transit on the campus, including the van to the stables, the van to Lynchburg, and "road-trip" services on weekends. These vanpools are very effective means of "cleaner" travel since theoretically they result in less pollution per passenger than a car. Unfortunately, very few people take advantage of this opportunity to save pollution. Many individual cars are driven to the stable daily, while the van runs with sometimes one or no passengers at all. The vans to Lynchburg run several times a week. The average amount of passengers on those van runs is from one to six people.

A vanpool is an excellent measure to reduce the amount of fossil fuels burned and diminish greenhouse gas release. There is one main measure that could be taken by the college to limit the amount of pollution given off by the van service. That would be to convert the mass transit vans to compressed natural gas fuel. "It burns cleanly, starts easily, and has an extremely high octane rating (130, vs. about 105 for methanol and the low 90s for premium gasoline)" (Kupfer 74). One drawback of natural gas is that only the amount needed to operate for 100 miles can be carried at one time. This is a good option, then, only for short-run vans.

In Sweet Briar's history, there was a bus driver named "Bus" Rhea. For many years, Sweet Briar women took the bus to the Sweet Briar station where they could take the train to Lynchburg, home, or to see their boyfriends. In the time this bus was operating, Amherst was quite the place to go to on Saturdays. It was like going into Lynchburg now. "As Miss Adeline Ames, the professor of botany who came in 1919 recalls, `Our amusements in the twenties were unsophisticated. Walking was still one of the chief diversions and on Saturday afternoons the traffic by foot on the back road through the woods to Amherst was heavy'" (Stohlmann 141). Students could pay fifteen cents to ride with "Bus" Rhea back to the campus. Alternatives to extensive student car use to obtain supplies include walking or bicycling. The information center could offer all-terrain bikes with big baskets for students to borrow and ride into Amherst. This would save a good amount of tailpipe exhaust.

Most of the service trucks and vehicles that the campus owns have catalytic converters installed. At present, the college is trying to phase out all of the older vehicles for newer and cleaner cars. Also, the mail truck could be replaced with either a small electric car or walking route. An electric car would produce much less greenhouse pollution. A walking route produces no greenhouse pollution. The stables mail could be passed onto the driver of the stables van. And, possibly in bad weather, a school vehicle could be used to deliver the mail.

Today there are approximately 290 student registered cars on campus. In the past, Sweet Briar women used to travel by horse and buggy, trains, buses, biking, and walking. Today most travel is by individual cars. Students could consolidate trips and take as many people who wanted to go to Lynchburg as possible. They could take the van service to Lynchburg even if the trip lasts longer than they want it to. They could purchase products in Amherst instead of driving to Lynchburg. (Some students have reported drives to Lynchburg for one item which could have been purchased in Amherst.)

Students and other car owners on campus need to become more aware of the amount of pollution they are putting into the atmosphere. "On average, riding mass transit instead of driving cuts hydrocarbon emissions that produce smog by 90%; carbon monoxide by over 75%; and nitrogen oxides by 15-75%, depending on the mode of travel" (Caplan 27). If people choose to travel via mass transit more often, a difference could be made in the amount of pollution that contributes to the greenhouse effect. "The time has come for Americans to wake up to what has been abundantly clear for many years now -- our dependence upon the automobile is destroying our environment and very likely our planet. The private car just isn't a viable means of transportation any longer" (Null 11). If one were to read data charts, it would look like the United States is trying hard to lead in the amount of automobile emissions. "This country's motor vehicles contribute more carbon dioxide (the major greenhouse gas) than any country except the Soviet Union and China. Transportation sources in this country cause 40 to 60% of the pollution that produces ozone smog and 70 to 80% of carbon monoxide emissions" (Caplan 25).

Some things can be suggested to help with the amount of pollution from campus registered cars. One plan might be to have a special inspection sticker that the college administers. Either on or off campus, an inspection station can be set up that inspects for the amount of emissions from a car. The college could put a special limit similar to those in California and Denver. In order to get a permit to park in one of the school's parking lots, a car must pass emissions inspection. This would make sure that all the cars are not emitting a large amount of harmful gases to the atmosphere. An alternative plan would be to make parking privileges very expensive and hard to obtain. This plan would keep the number of cars on campus down to a minimum, encourage carpools, and likely raise strenuous objections.

The college could also offer more van services. One van service could be offered to Washington and Lee University on Wednesday nights. On Thursday night, one van could go to Hampton-Sydney College. On weekends, vans could run to both colleges. Van services could also be offered at holiday times and vacation times to the airport, the train station, and the bus station. During the holidays many taxis are going back and forth from the college to travel areas. Van service could take more people in less trips, thus being less of a polluter.

Another addition to the transportation plan could be to have the public bus that runs in Lynchburg travel to Amherst via the gate of Sweet Briar College. This might want to be run on a trial basis to see how many passengers utilize this opportunity over a period of time.

On an individual level, citizens can be kept informed of alternative cleaner fuels and the importance of buying cars with good gas milage.

CFC's are another greenhouse gas that we, at Sweet Briar College, can help to control. When aerosols with CFC's were popular, they were used on campus. But, when they were banned from aerosols, that emission died out on Sweet Briar also. Today CFC's are present in refrigerators and air conditioners, common products at Sweet Briar. Most rooms have at least one refrigerator. The newer dorms have air conditioners installed in them. Most cars on campus have air conditioners. It is important that CFC's do not leak out of these systems into the atmosphere. When car air conditioners stop working, it is usually related to leakage of CFC's. When an air conditioner "needs to be recharged," new CFC's are needed in the system. Leaks should be identified and repaired. CFC's can be collected and reused rather than released.

The school's refrigerator systems and rental refrigerators should be checked annually for leaks. When the school disposes of a refrigerator, it should be taken to a store that recycles refrigerators rather than to the dump. Air conditioners should be checked for leaks, possibly during spring break before they are turned on and during Thanksgiving break before they are turned off.

According to Joel Levine, biomass burning produces more carbon monoxide, methane, and nitrous oxide pollution than fossil fuels burning. Sweet Briar College has over 3,300 acres of land. Some of this acreage is managed forest land. When a forest is managed, it is harvested in two methods: selective cutting and clear cutting. (See Chapter 6.) Clear cutting is usually practiced when reforestation of a whole plot of land is planned. On campus, reforestation is done with pine trees. After a plot of land is clear cut, a prescribed burning takes place. The purpose of this burning is to get rid of the debris left after the clear cut. A fire barrier is created around the plot to be burned. Then, the fire is started with a fifty-fifty mixture of gasoline and diesel. Another alternative is to bulldoze the debris left from the clear cutting into piles and then burn.

Over the years, Sweet Briar has burned only about sixty to seventy acres in about a half dozen fires. In Virginia, approximately eighteen to twenty thousand acres a year are burned. These are occurring all over the place including surrounding the campus. But, what are alternatives to these prescribed burning? One alternative could be that the debris be left and the reforestation occur around the debris. Most of this debris is tree parts and bushes and possible ground cover. Another possibility is that the debris that is blocking reforestation be removed by hand and recycled. This way, resource recovery is used instead of creating more greenhouse gases that aren't needed.

### A Note to Sweet Briar Students

If the above ideas are followed for Sweet Briar College, than Sweet Briar can cut down on its contribution to global warming. But, now, hopefully you are fired up about the problem and want to do more. There are lots of things you can do. The first, and most important thing, you can do is become educated and keep educated as new things come out. Look at data in a critical way. The next thing you can do is inform people who want to know more. Teach them how to get started. Show people by example. For example, start taking your own bags to the grocery store: not only does this cause less pollution and resource degradation, but it also makes a statement to people. The next thing you can do is write letters. Encourage policy makers to make wiser decisions when it comes to global warming and other environmental issues. Ask them to start acting now instead of later. Start pressuring the industry to clean up their act. And also pressure them into producing more efficient cars and better, cleaner fuels. They already have the technology for the cars, but they say consumers don't want them. Prove they're wrong. Most of all, live your life in a way that is sustainable. "Our environment is giving us very strong messages that our cooperation is needed if it is going to continue to provide us with a safe, hospitable place to live" (Null 17).

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## CHAPTER 4

# ATMOSPHERE: INDOOR POLLUTION

by Renee Merion

### Introduction

Recently there has been increased awareness of indoor air pollution. The 1980's began the concern about indoor air quality with the increasing research on radon and other indoor airborne contaminants. Indoor air pollution can reach levels up to five times worse than the air outdoors on the most polluted day (National Wildlife 41). People spend 85 to 90% of their time indoors. Therefore, there is a strong need to monitor and regulate indoor air pollution. There are many concerns about air pollution and its adverse effects on health.

Each day, the average person's respiratory system has to eliminate over two heaping tablespoons of particulate matter (dust, pollen, tar, acids, smoke, bacteria, rubber, carbon, metals, etc.). Small wonder that a growing percentage of the population has chronic sinusitis, allergies, asthma, inflamed eyes, and other symptoms caused or aggravated by air pollution (King 1).

The three main factors determining health risks due to pollutants are: 1) determining the concentration of the pollutant, 2) the duration of exposure, and 3) the number of people exposed. Some studies also take into consideration the general health and susceptibility of the people being studied. Indoor air pollution creates more of a problem for those who are highly sensitive to pollutants like the very young, the ill, and the elderly. Studies measuring air pollution effects should be weighted to reflect these differences. This method is also helpful when assessing the risk of other pollutants including outdoor air pollution (Conservation Foundation 479-490).

### Indoor Air Pollutants

There is a wide variety of air pollutants. Indoor air pollutants are found in homes, offices, workplaces, planes, cars, trains, and any other type of building or contained area. Common indoor air pollutants come from building materials, consumer products, supplemental heaters, and cigarette smoke. Contrary to these air pollutants, radon is generated naturally from bedrock and permeates through the ground into buildings. This form of indoor air pollution cannot be as easily avoided or corrected as the anthropogenic air pollutants. The others can be somewhat controlled by consumer purchasing and personal health decisions.

After the energy crunch of the 1970s it became common practice to build new homes in a more energy efficient manner. Unfortunately, high levels of indoor air pollution can be found especially in homes that have tight ventilation systems, allowing little air flow from the outside. The reaction to decrease air flow in homes to reduce energy use and costs has increased the problem of indoor air pollution (King).

Wood stoves, coalburning stoves, and kerosene heaters, which are used as supplemental heaters, can also add to the problem of indoor air pollution. Wood stoves emit particulates, especially polycyclic organic matter. POM compounds are carcinogenic to animals and perhaps to humans. People living in homes with wood stoves seem to have a higher incidence of colds and respiratory ailments. Supplemental heaters which use kerosene or oil can emit pollutants such as carbon monoxide and nitrogen dioxide which cause minor and severe health problems. Today, homes are generally less polluted than homes of the past since there is less use of fireplaces and coal stoves for heating and cooking. Homes that do use them are generally better ventilated and have less leakage into the home itself. However, older houses are less tightly ventilated and have a higher exchange of outside to inside air. More ventilation does not offset the higher air pollution (King).

Indoor air pollution may also come from consumer products: paint thinners, pesticides, aerosols, cleaning products, furniture, solvents, carpets, plywood, particle board, and foam insulation. The major cause of airborne contamination emitted from some of these products is formaldehyde, a gas that can cause irritated eyes, "sneezing, coughing, and other health problems... and has been shown to cause cancer in animals and may cause cancer in humans" (U.S. DOE 1). Other harmful materials can be physically irritating and may cause "irregularities in the metabolic and central nervous system" (U.S. DOE 2). Measures should be taken to reduce exposure to these types of products by eliminating them and substituting less harmful products in their place. These types of products should be used in well ventilated areas.

Indoor air pollution from consumer products is a problem both in the home and the workplace. One indoor air pollutant that has received a lot of attention in the 1980s is asbestos. Asbestos was used in the past for insulation and now remains in many buildings. As buildings age, insulation can loosen and allow asbestos fibers to become airborne. Once inhaled, these fibers lodge in the lungs and can cause lung cancer. There has been a major effort to reduce exposure to asbestos fibers by coating it with a chemical sealant or by replacing the insulation. State and Federal legislation has been enacted to eliminate dangers of asbestos in public building such as schools. However, homes can be a critical source of asbestos fibers since most people spend most of their time indoors in their own homes. Many may be unknowing of the danger of insulation in their own homes and, therefore, fail to get appropriate help in removing or treating it.

Under the Federal law, public buildings and schools must remove or seal up all potentially hazardous asbestos. As a private facility, Sweet Briar does not have to abide by the legislation governing public schools. However, Sweet Briar examined the asbestos situation on campus and has a plan to have it properly removed or treated. (Connors).

Perhaps one of the most widely known and protested indoor air pollutants is tobacco smoke. Smoking combines with other pollutants to multiply the harmful effects of airborne pollutants. "Tobacco smoke contains 60 known carcinogens, as well as many hazardous chemical compounds and particulates" (U.S.DOE 2). These pollutants may be a danger to nonsmokers, as well as smokers. Nonsmokers who have a spouse that smokes have a 30% higher incidence of lung cancer and are more likely to have respiratory related disorders compared to nonsmoking spouses of nonsmokers. This pollutant is not limited to the home environment but is present everywhere. There is currently a lot of pressure on public officials to limit the areas in which one can smoke. In some places legislation is already in effect. To some extent, Sweet Briar has regulation on smoking. The College complies with state laws to ban smoking in most public places. In a building where indoor pollutants are above standard levels, the first measure that should be taken to reduce amounts is to eliminate smoking.

## Smoking Survey

A smoking survey (Appendix B-1) was given randomly to Sweet Briar students to get a general idea of smoking habits. The results are shown below in Table 4-1.

It gives a general idea of how students perceive smoking and their reaction to smoking especially in public places. Only a few students, smokers and nonsmokers, responded that secondhand smoke did not bother them. Many, on the other hand, said that smoke bothered them most while eating. A frequent comment on where students would like to see stricter smoking regulation at Sweet Briar listed Prothro Commons. Several listed the Bistro as well. Another candidate for stricter smoking limitations was academic buildings, especially in the lobby of Benedict. An interesting finding was that when students who smoked were asked the reasons why they did, only a few responded that they actually enjoyed it while the large majority said that they started because of pressure and stress. The majority started in their freshman or sophomore years. Perhaps the most surprising outcome of the survey was the response to the question of what students thought was the percentage of students that smoked. The majority of the responses were from the 50% to 75% range, while only 25% of the

TABLE 4-1. SMOKING SURVEY RESULTS:

1. Whether you smoke or not, are there times that smoke bothers you?
Yes - 96% No -4%

2. Where does it bother you the most?

| | |
|---|---|
| Dining hall | 17% |
| Room | 13 |
| TV rooms/lounges | 13 |
| During tests/exams | 10 |
| Bathrooms | 9 |
| Academic buildings | 8 |
| Bistro | 8 |
| Halls | 6 |
| Professors' offices | 6 |
| Crowded/unventilated rooms | 2 |
| Cars | 1 |
| Laundromat | 1 |
| Elevators | 1 |
| Other: Everywhere | 4 |

3. How do you feel about smoking bans in public places?

| | |
|---|---|
| Agree with them/good | 63% |
| Disagree with them/unfair | 13 |
| Good in some places, unfair in others | 21 |
| Indifferent | 4 |

4. Do you think SBC needs stricter smoking regulations?
Yes - 58% No - 42%

a. Where?

| | |
|---|---|
| Prothro Commons | 61% |
| Public hallways | 13 |
| Benedict lobby | 6.5 |
| Bistro | 6.5 |
| Professors' offices | 3 |
| Classrooms | 3 |

5. In your opinion, what per cent of SBC students smoke?

| | |
|---|---|
| 0 - 40% of students | 6% |
| 50 - 59% | 25 |
| 60 - 69% | 21 |
| 70 - 79% | 31 |
| 80 - 89% | 10 |
| 90%+ | 8 |

6. If you don't smoke now, did you ever?
Yes - 27% No - 73%

a. For how long?

| | |
|---|---|
| Less than 1 year | 11% |
| 1 - 1.5 years | 33 |
| 2 - 2.5 years | 56 |

b. Why did you quit?

| | |
|---|---|
| Health reasons / fears | 31% |
| Dislike | 25 |
| Medical reasons | 13 |
| Made me sick | 13 |
| Athletics | 6 |
| Monetary | 6 |
| No reason | 6 |

7. Do you smoke? Yes 41% No 59%

8. How long have you smoked?

| | |
|---|---|
| Sometimes/infrequently | 8% |
| Less than 1 year | 13 |
| 1 year | 4 |
| 2 years | 17 |
| 3 years | 13 |
| 4 years | 13 |
| 5 years | 25 |
| 6 years or more | 8 |

9. Where do you smoke the most?

| | |
|---|---|
| Room | 34% |
| Parties | 48 |
| Dining Hall | 7 |
| Cars | 7 |
| Other | 3 |

10. Did you smoke when you came to SBC?
Yes - 31% No - 69%

11. If not, when did you smart smoking?

| | | | |
|---|---|---|---|
| Freshman | 80% | Junior | 0% |
| Sophomore | 20 | Senior | 0 |

12. Why did you start smoking?

| | | | |
|---|---|---|---|
| Pressure / stress | 39% | | |
| Enjoy it / want to | 25 | It's cool | 3.5% |
| Peer Pressure | 7 | Boredom | 3.5 |
| Everyone else does | 7 | Diet | 3.5 |
| Something to do with hands | | | 3.5 |
| To be sociable / parties | | | 3.5 |

students asked responded that they smoked. Hopefully, a more detailed and widespread survey of smoking habits of Sweet Briar students can be given as a follow-up to this survey.

Awareness of radon and the danger that it poses has dramatically increased in the past few years. Radon is thought to be the cause of 5,000 to 20,000 deaths out of 100,000 Americans that die from lung cancer each year. Radon is a colorless, odorless, radioactive gas that permeates through the soil beneath buildings. Radon finds its way into buildings through cracks in the foundation, loose pipe connections, and water supplies. Radon gas decays from uranium into "radon daughters" which attach to particulates in the air and, when inhaled, cause lung cancer. Those who smoke in a building that has high radon levels are particularly in danger since smoking provides airborne particles on which the radon particles attach. Also, smokers are in greater risk of radon since radioactive particles, once inhaled, become lodged in tar in the lung and cannot be expelled as easily. There are several, fairly inexpensive methods of measuring the level of radon indoors. If levels are high, there are several steps that can be taken to reduce exposure. Installing heat exchangers are one of the most popular methods. A somewhat more expensive method is to install a ventilation system under the foundation so radon does not concentrate in the building.

## Air Purifiers

Many people have turned to home air purifiers to ease their worries about indoor air quality. As to be expected, there are contradicting beliefs about the effectiveness of air filters. There are many different types. Most home air filters are tabletop units that are easily transported for convenience. Filtering devices use several different methods for collecting pollutants or particulates. There are mechanical filters, chemical filters, and electrostatic precipitators available for personal and home use. The mechanical air purifiers contain several removable filters that have very small openings to allow airborne particulates to be trapped within them. Usually the filters are made out of glass fiber, fabric, plastic, wood, metal, or other materials which have to be replaced after a period of use just as chemical filters do. Chemical air filters are made out of activated carbon, activated alumina, or charcoal which absorb airborne chemicals such as ozone and other gases. The third major type of air purifiers is the electrostatic precipitator which puts a negative charge on entering particulates which then are attracted to a positively charged area or wall inside the device (Hopkins 122) or vice versa. Their filters may be reused after simple cleaning. These filters only collect particulates and do not filter any types of gases.

There are a few concerns with these types of air purifiers. Are they as effective in combating indoor air pollution as they claim? People considering the purchase of a filtering unit should pay particular attention to the type of contaminants of concern. Warning is given by many to recognize their efficient life-span and maintenance requirements. Some people, such as Gordon King, recommend, the HEPA (High Efficiency Particulate Air) filter since it requires minimal maintenance and shows comparably good performance.

Included in the smoking survey was a brief section on air filters. Students were asked if they had any experiences (at home, school, or at work) with air filters or if they had ever considered purchasing one. If they had, they were asked if the filters made any difference and, overall, how well they performed. Approximately 20% of the students who answered this part of the survey (Appendix B-2) had experience with air filters. Of the students who had experience with the use of air filters, 50% said that they were helpful in treating air quality in home or work environments. Most of these students were unable to give any more detail of the circumstances of the use of the filters. About half of the students (51%) responded that they had considered purchasing an air filter. When asked if they thought that they would respond differently when provided with more information about the adverse health effects of indoor air pollution, mainly cigarette smoke, 84% said that they would. The remaining 16% said that they probably would still not consider purchasing an air filter. Many students did not know exactly what an air filter was and general information on filters was shared with them. A few had no idea what air filters were or what they did.

Further investigations of indoor air pollution at Sweet Briar would be appropriate. Do air filters make a difference in rooms likely to have fumes such as photography development labs, chemical storage labs, and duplicating rooms? Do the building materials used in renovations, especially panelling and carpets, give off indoor air pollutants? Are there other appropriate alternatives? Are there particular concerns for offices that are in basement locations? Are there alternate smoking policies which might be encouraged and tried? With increasing knowledge about indoor pollution, we need to increase our awareness about possible effects of air pollution and options we have for minimizing problems through behavioral, policy, and technological changes.

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# CHAPTER 5

# HYDROSPHERE: WATER RESOURCES

by Jane Heinze-Fry and Jennifer Valentine

## Introduction

Water is a crucial natural resource. Through the hydrologic cycle, the atmosphere, the land, and all bodies of water are interconnected. Natural and humanmade ecosystems, as well as all organisms within those ecosystems, are profoundly affected by the quantity and quality of the water supply. Global water use patterns include: growing demand for water, partly on a per capita basis and partly because of human population growth; declining water quality; increased international disputes over water; correlations between infant mortality and access to clean water; and concern over groundwater pollution (Citizen's Guide to Sustainable Development 154-163).

Water makes up about 70% of the human body. It is essential for life as we know it. Although water covers about 71% of the earth's surface, 97% is salt water. Of the remaining 3% fresh water, three-quarters is too far below the earth's surface or in glaciers and is, therefore, not available for consumption. Only one-quarter of the freshwater or 0.5% of all the earth's water is found in lakes, rivers, and underground sources. With only this small percentage of water available, Americans still use water as if it were a perpetual resource. Agriculture, industries, and homes place large demands on the water supply (Miller 209-214). In the United States, the average per capita use is on the order of 1600 gallons per day. Only 1 gallon forms the liquid part of the diet. Another 60 gallons are used at home. Some is used at offices, or other public places. Industrial production carries the heaviest consumption totalling 1500 gallons per capita per day (Hinckley 17, 20).

Water quality as well as water quantity is significant for the maintenance of a healthy ecosystem. Awareness of water pollution sources, effects, and alternative solutions has grown over the last two decades. Initial concerns about the quality of U.S. waters resulted in regulation of point sources of pollution, such as factories, sewage treatment plants, or electric power plants, which discharge wastes at a particular location. Recently, nonpoint source pollution in which pollutants are widely scattered and discharged over a large area, such as agricultural runoff and urban centers into surface water or seepage into groundwater, have become a focus for policy makers (Miller 456). Initially, protection of surface water quality captured the public's eye. More recently, groundwater protection has been emphasized (Burmaster 7-36; Stein 1,6).

Water quality conditions are often assessed by measuring concentrations of specific contaminants. Although there were some water quality improvements, general trends from 1974 to 1981 from 501 monitoring stations composing the National Ambient Stream Quality Accounting Network of USGS showed a decrease in water quality. Nutrient measurements indicated that phosphorus reported slightly more stations showing improvement rather than degradation, although nitrates showed about three times more stations reporting the reverse. One possible explanation is increased agricultural land use and fertilizer use (State of the Environment 93). Nutrient increases are an area of concern because of the potential increase of enhancement of eutrophication (Hutchinson 269) as well as algae blooms with consequent blockage of light to underlying plants and oxygen depletion (State of the Environment 93). Chlorides (salt) concentrations show more degradation, possibly from deeper groundwater use, seawater intrusion in coastal areas, and heavily irrigated saline soils (State of the Environment 99). An increase in suspended solids probably reflects an increase of land use for agriculture and silviculture (State of the Environment 92). Declining fecal coliform and slight improvements in dissolved oxygen are attributed by USGS to improved treatment of municipal wastes and the reduction of feedlot runoff (State of the Environment 90, 92). To further reduce municipal wastes, some consideration has been given to land use of wastewater and sludge (Crites 140A-147A) as well as alternatives to sewers (Leich 38-44). Although lead shows a gratifying decrease in the water supply, attributable to the switch to unleaded gasoline, other metals (arsenic, cadmium, mercury) showed increases with fossil fuel combustion and atmospheric deposition being one of the most likely sources (State of the Environment 94-95). Pesticide residues on crops and runoff into water supplies has been a growing area of concern (Mott and Snyder 20). Regulation of pesticides has proven very difficult (Sun 238).

Water pollution control legislation has evolved over the course of the last two decades. It emerged from debates between two philosophical perspectives: one perspective more ecologically oriented, the other more technologically oriented (Westman 767). The resulting complex legislation has done remarkably well in synthesizing these two views, taking into account the more technological water pollutants of "dissolved solids, suspended solids, and settleable solids", and the more ecological pollutants of "nutrients, non-nutrients, toxic substances, and pathogens." Legislation addresses such diverse areas as water diversion, groundwater tapping, water resources development (dams), lakes, rivers, wetlands, outdoor recreation, oil and hazardous waste cleanup, protection of drinking water, point and nonpoint sources of pollution, and ocean dumping (Goldfarb). Water bills have been a major area of concern in Virginia this year. Bills have been introduced regarding oil spills, gas drilling, drinking water protection, solid waste and recycling, wetlands protection, sewage handling, and tax credits for the purchase of advanced pesticide application technology for those with an approved nutrient management plan ("Legislators..." 1-2; "Water Bills..." 3).

## Water Supply at Sweet Briar

How do understandings of water quantity, quality, and legislation come into play at Sweet Briar College? First, a look at water quantity. Sweet Briar has a good supply of water. The watershed at Sweet Briar is approximately 660 acres. (See Figure 5-1.) With an average annual rainfall of forty inches, the watershed yields approximately 660 million gallons of water per year. This is far more water than the lakes are able to hold. The surface area of the large lake is approximately seven acres. The volume is about thirty-one million gallons. The small lake is approximately four acres and holds about two million gallons (Edwards).

## Water Consumption at Sweet Briar

With all of this water, one might think that Sweet Briar has no problem supplying water for the thousand or so people that use it. Sweet Briar, however, uses about three million gallons of water a month, which is approximately 100 gallons per capita per day. Assuming that the water supply only serves 1,000 people during the nine months that school is in session, that is 27 million gallons, or almost the entire large lake!

It is estimated that water is used at about half the normal rate during the summer, about 50,000 gallons per day (Mason-Viers). Given that Sweet Briar may increase its water demand because of increased summer programing, it seems prudent to keep water supply and demand in mind with planning for the future. It should be noted that Sweet Briar College has interfaced with the city of Amherst water supply on an emergency basis in the past. An interacting role should be kept in mind as one possibility for the future (Armstrong).

The only water meter at Sweet Briar is at the water treatment plant. Therefore, it is uncertain how much water is consumed for various uses such as drinking and cooking, showers, and flushing toilets. If we knew how much water was used for different purposes, it would be easier to target major uses for a water conservation plan. What we do know is that the volume of the swimming pool is about 937.5 cubic meters. (Kirmann). The water is filtered and recycled within the pool's closed system. About

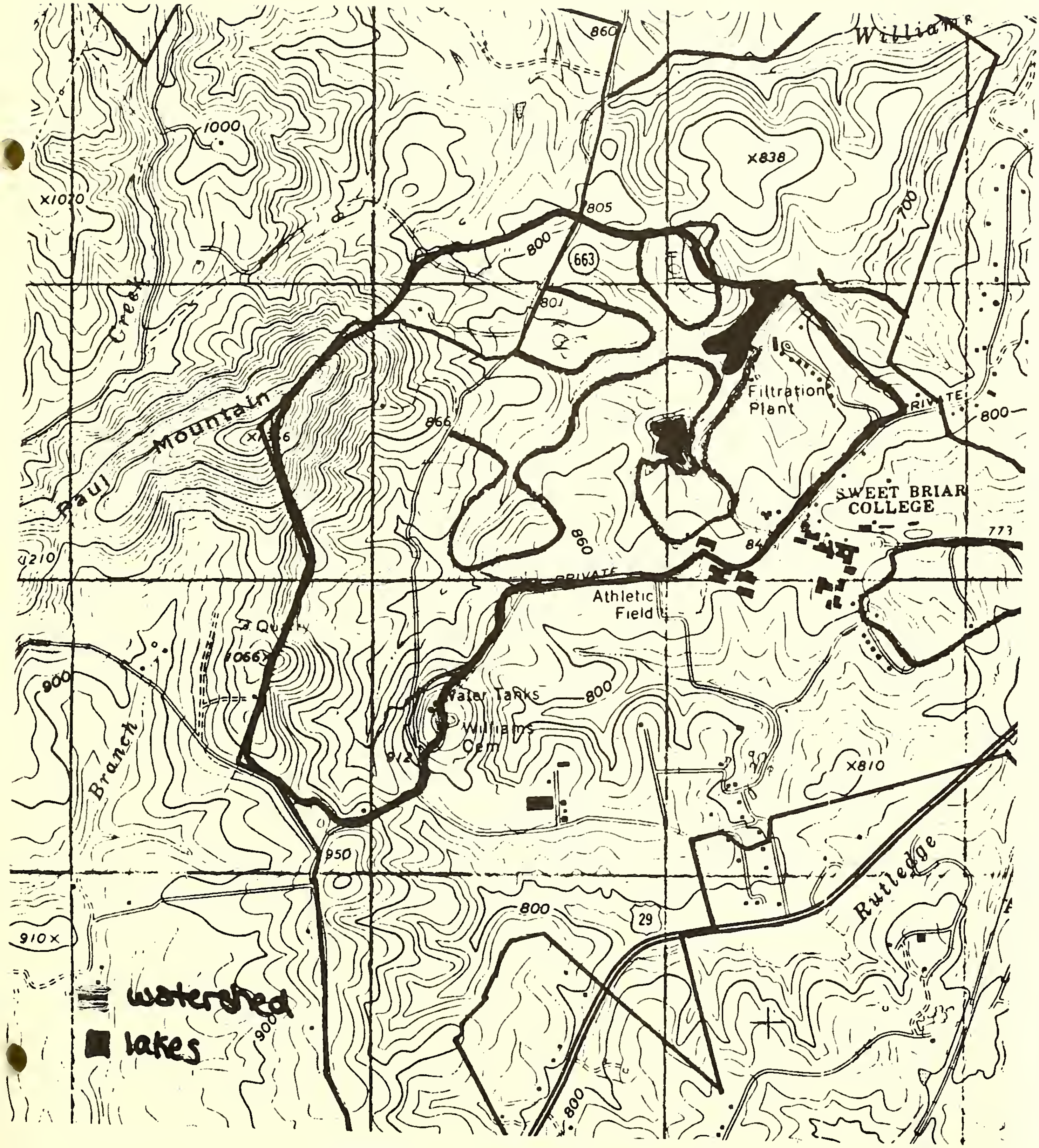

Figure 5-1. Sweet Briar Watershed

two inches of water is added each 3 to 4 weeks because of evaporation. The pool was emptied two summers ago (B. Kestner).

In general, there are many simple water conserving strategies which could cut water consumption by the Sweet Briar Community. The most simple behavioral changes about which the community could be educated include reporting leaks, not leaving the water running when brushing teeth, and using only as much ice as is needed. Consideration in renovations should be given to water-saving showerheads, which can save up to 50% of shower water, and low-flow toilets (Citizen's Guide 169).

## Water Quality: Water Treatment Plant

How does Sweet Briar stand with water quality? Sweet Briar has its own water treatment plant. Environmental Studies students toured the plant with operator Lucy Mason-Viers this year. The objectives of water treatment are to: 1) make water safe for human consumption at the tap as well as at the water treatment plant; 2) make water aesthetically pleasing to consumers without odor, color, or bad taste; and 3) strive for economical operation. The water treatment plant at Sweet Briar consists of the plant itself and two storage tanks: one 500,000 gallon and one 75,000 gallon capacity. The treatment process begins by pumping raw water from the lake (Photo. 5-1) into the contact unit (Photo. 5-2). Here, alum (5.2 ppm; Photo. 5-3) is added to cause particles to flocculate, and chlorine (2 ppm; Photo. 5-4) is added to kill disease-causing organisms. In the Graver unit (Photo. 5-5), soda ash (10.4 ppm) is added to neutralize the pH of the water. The water settles (Photo. 5-6) and is run through a sand filter (Photo. 5-7). Finally, lime (1 gpg) and more chlorine are added to the water. In addition to the lake, Sweet Briar has a well. Water ready for distribution will only have 1 ppm chlorine and 2 ppm lime because the soda ash and alum settle out in the treatment process (Mason-Viers). Water treatment wastes from the contact basin, settling basin, graver unit, and filter backwash are sent to the waste water shed (Photo. 5-8) and ultimately to the Amherst sewage treatment plant. (See flow diagram in Appendix C-1, a description of commonly run analyses on public water supplies in Appendix C-2, and a memorandum on the SBC water supply in Appendix C-3.)

## Water Quality Testing

Water at Sweet Briar is tested by the Virginia Department of Health's Division of Water Supply Engineering. Results of water quality tests indicate that Sweet Briar exceeds the health standards set by the department (see Appendices C-3 and C-4, Table 1). Sweet Briar's water supply is reasonably well-protected by forest buffer zones

Photo. 5-1. Lower Lake. The lower lake is the primary water source for the college. When turbidity levels are high, the upper lake above the manmade earth dam is a secondary water source.

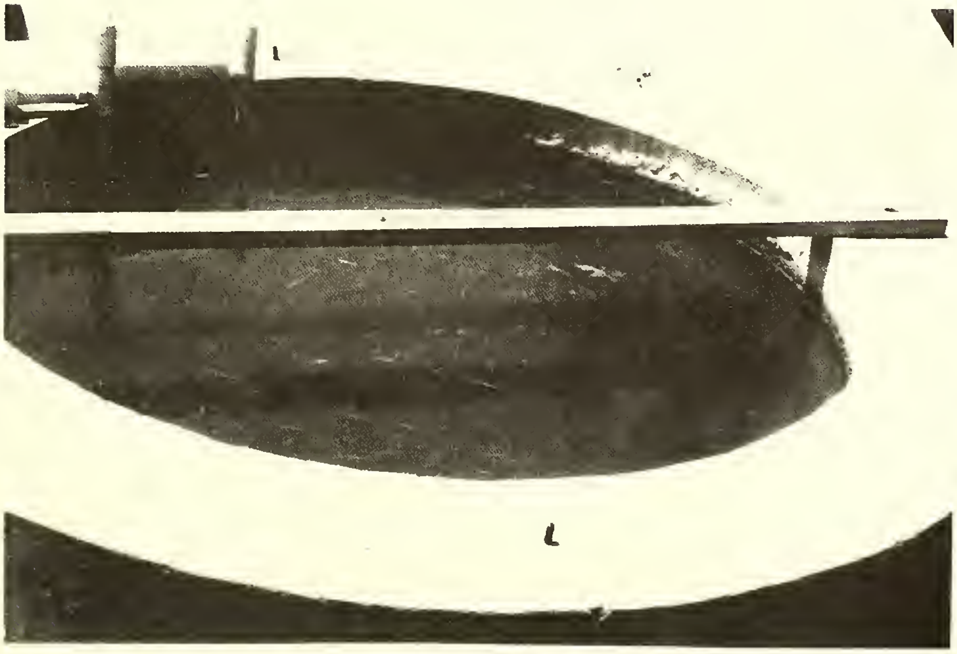

Photo. 5-2. Contact Basin. Here raw water from the lake is treated with alum and chlorine.

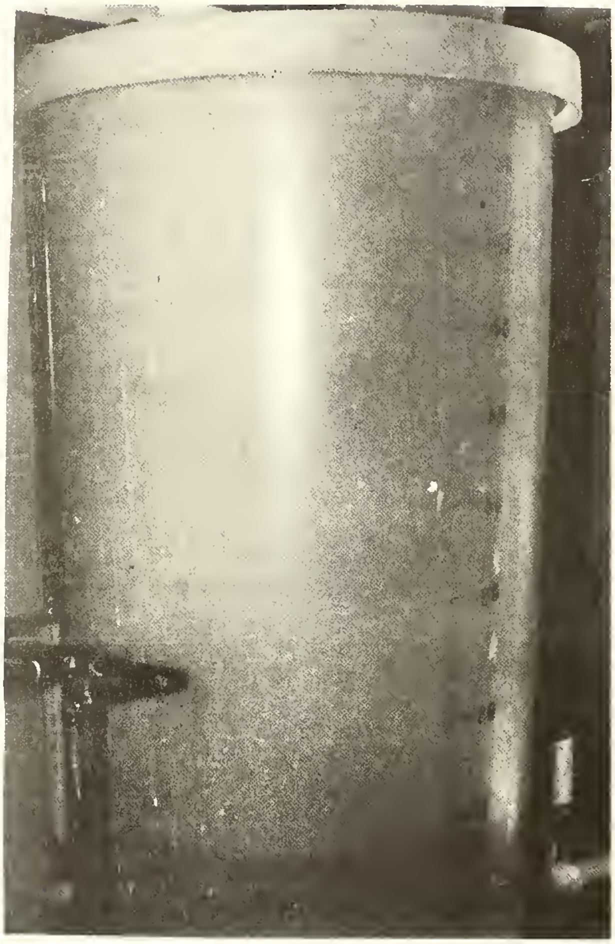

Photo. 5-3 (left). Alum. Alum is added to the water to cause flocculation.
Photo. 5-4 (right). Chlorine. Chlorine is added to kill potential disease-causing organisms.

Photo. 5-5 (left). Graver Unit. Soda as is added to neutralize the pH.
Photo. 5-6 (below). Settling Basin. The floc settles out and is sent to the wastewater shed.

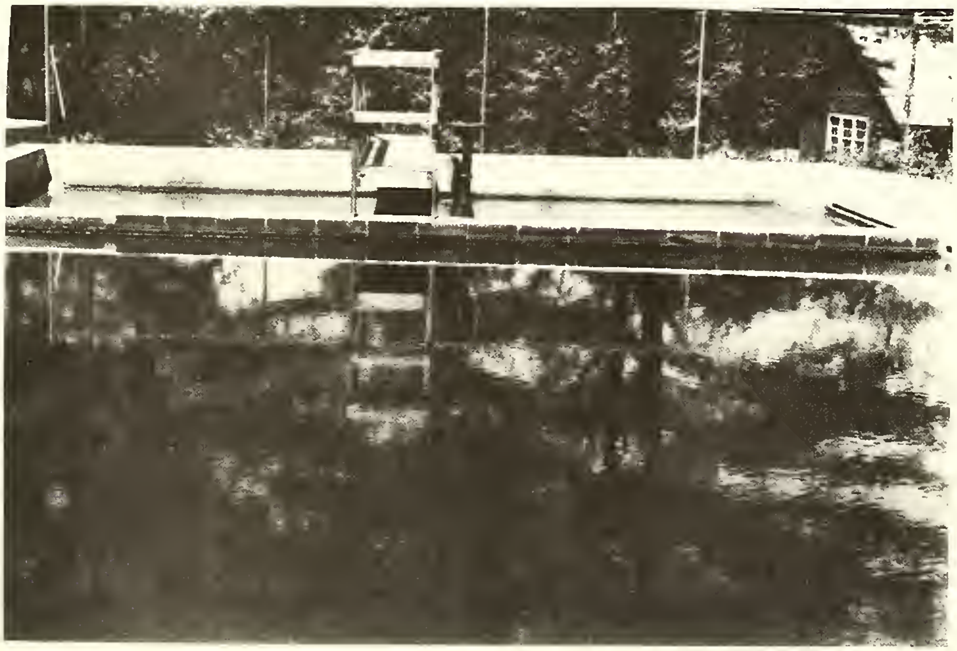

Photo. 5-7. Laboratory Testing and Sand Filter House. Treated water is filtered through sand. All water tests are done here.

Photo. 5-8. Wastewater Shed. Water treatment wastes from the contact basin, graver unit, and filter backwash are sent here, then to the sewage treatment plant.

between the water supply and agricultural lands. Minimal levels of pesticides are found in Sweet Briar's water. (See Appendix C-4, Table 3.) The pesticides used on Sweet Briar croplands are the herbicides Eraxmone, Paraquart, Princep, Atrazin, and Laso and the insecticide Furidane. (See Chapter 7.) Surflan, Round Up, diazinon, and malathion are used on the lawns (Chapter 9). Because of brand name labels, as opposed to active ingredients, it is unclear at this time if these pesticides were tested for in the drinking water. This should be checked, as well as the pesticides used by the one other landowner whose land is adjacent to the Sweet Briar watershed. Because of the possibility of groundwater pollution, it would also be advisable to test the well water for all pesticides used in the watershed. Other tests on inorganic metals (Appendix C-4, Table 2) and radiological substances (Appendix C-4, Table 4) were all below the maximum allowable levels. To comply with new state regulations to protect underground water supply, Sweet Briar disposed of an old underground gas tank and inspected remaining tanks for leaks (Connors).

## Pilot Study: Can Sweet Briar Students Distinguish between Tap Water and Filtered Water?

In spite of the fact that Sweet Briar's water exceeds state water quality standards, many students, reflecting a nationwide trend, buy and drink bottled water. Renee Merion conducted a taste test of Sweet Briar students to see if they could distinguish between tap water and water filtered with an NSA water filter (courtesy of Mikel Davis). She also surveyed students for their knowledge about water quality, their attitudes toward the taste of Sweet Briar's water, and their bottled water buying habits.

The water taste survey (Tables 5-1, 5-2) was given randomly to Sweet Briar students who wished to participate. Students seemed more interested in participating after realizing that it enabled them to comment on their opinion of Sweet Briar water, and that it may have some influence on improving the water's taste. The dorms were mentioned most frequently as having the worst tasting water on campus and Prothro as having the best tasting water, since its water is already filtered. Many of the students went on to ask questions about the water and why it tasted different in some locations. They wanted to know why the water in Prothro Commons did not taste the same as other parts of the campus and why the new dorms do not have any better tasting water than the other dorms. They were very interested to find out information about the water supply. They also had a lot of concern for the safety of Sweet Briar water mostly due to the bad taste and discoloration at times.

## TABLE 5-1. PERSONAL INFORMATION ON WATER PREFERENCE

1. Do you buy bottled water?

a. At SBC? Yes - 68.5% No - 31.4%

b. At home? Yes - 37.6% No - 62.3%

c. Why?

| | |
|---|---|
| SBC water tastes bad | 14% |
| Bottled water tastes better / cleaner | 49 |
| Tap water has too much chlorine | 1 |
| Like taste of bottled water | 14 |
| Used to bottled water/grew up with it | 5 |
| Afraid to drink tap water | 2 |
| Don't drink water | 5 |
| Other | 9 |

d. How much do you spend?

| | | | |
|---|---|---|---|
| Not much | 17% | $11-15/month | 7% |
| A lot | 3 | $16-20/month | 7 |
| $2-5/month | 24 | $21-30/month | 3 |
| $6-10/month | 7 | $31-40/month | 7 |

The average price per bottle was $1.30.

2. Do you regularly drink the water at SBC?

Yes - 69% No - 31%

a. How many times a day?

| | | | |
|---|---|---|---|
| 0-1 | 12% | 6x | 2% |
| 2x | 22 | 7x | 2 |
| 3x | 23 | 8x | 7 |
| 4x | 7 | a lot | 2 |
| 5x | 17 | Not much | 1 |
| continually / all day | 6 | | |

b. How many glasses a day?

| | | | |
|---|---|---|---|
| 0-1 | 13% | 6-8 | 22% |
| 2-3 | 32 | 9-15 | 5 |
| 4-5 | 18 | a lot | 10 |

c. Do you have any comments about SBC water (ie.taste)?

| | |
|---|---|
| Bad taste/smell | 42% |
| Tastes better cold / with ice | 6 |
| Fine / OK | 12 |
| Metallic / pipe / iron taste | 14 |
| Chlorine taste | 12 |
| Depends on location | 1 |
| -good in Prothro | 3 |
| -good In dorms | 1 |
| -bad In dorms | 8 |
| -bad at water fountains | 1 |

3. Where do you drink SBC water?

a. in the dorms? Yes 60% No 40%

b. In Prothro? Yes 76% No 78%

c. from water fountains - In dorms or other buildings? Yes 70% No 30%

4. Would you use a water filter system in your own home?

Yes 71% No 27% Maybe 1%

a. Would you buy a water filter, given the cost?

Yes 67% No 32% Maybe 1%

b. Would you use a water filter if it was provided for you?

Yes 93% No - 7%

c. How much are you willing to pay?

| | | | |
|---|---|---|---|
| No idea | 60% | $75-80 | 1% |
| Nothing | 5 | $100 | 14 |
| Not much | 1 | $200 | 2 |
| $10-35 | 8 | $300-1000 | 1 |
| $50 | 5 | As much as needed | 2 |

5. Name 3 major US water quality problems.

| | | | |
|---|---|---|---|
| No answer | 20% | Contamination | 7% |
| Don't know any | 2 | Radioactivity | 2 |
| Acid rain | 3 | Metals | 2 |
| Bacteria | 2 | Pollution | 10 |
| Too much chlorine | 7 | Groundwater | 4 |
| Fluoride | 4 | Surface water | 1 |
| Lead | 3 | From Industry | 9 |
| Oil spills | 2 | From agriculture | 3 |
| Water recycle / reuse / waste / shortage | | | 4 |
| Inadequate treatment / processing | | | 5 |
| Other | | | 11 |

6. Does the taste test outcome urge you to use a water filter or not to use one?

Yes 68% No 30% Maybe 1%

7. Would it make a difference if more information were provided on drinking water quality in your own home?

Yes 92% No 7% Maybe 1%

TABLE 5-2 RESULTS OF THE WATER TASTE SURVEY

1. Which tasted better? Sample #l - 34% Sample #2 - 62% Neither - 4%

2. Does either one have any specific, noticeable taste? Describe any particular taste you detect (e.g., metallic).

| Taste | Sample #1 | Sample #2 |
|---|---|---|
| Bad taste | 5 | 2 |
| Chlorine | 5 | 1 |
| Flat / less taste | 0 | 2 |
| Fresh / clean | 2 | 4 |
| Lemon / bitter | 1 | 4 |
| Metallic | 27 | 10 |
| Mineral | 1 | 1 |
| Stale / stagnant / smelly | 5 | 1 |
| Like the paper cup | 6 | 1 |
| Plastic | 1 | 0 |
| Sharp taste | 1 | 0 |
| Smoother taste | 1 | 1 |
| Other: | 10 | 1(dirty, chalky, copper, rust, salty, treated) |

One person said both tasted bad.

3. Which one do you think is tap water?
Sample #l: 66% Sample #2: 31% Neither: 2%

4. Which one do you think is filtered water?
Sample #l - 31% Sample #2 - 69%

Sample number one was the tap water, sample number two was the filtered tap water.

The majority of the participants chose correctly as to which sample was tap water and which sample filtered (NSA) tap water (Table 5-2). A few people commented that they could tell that sample number two was filtered simply by the smell of chlorine in sample number one. In the beginning of the survey, not quite a half an hour since the water samples were collected, some students noticed a slight temperature difference. They said that the colder the tap water was, the better it tasted. However, the temperature difference was only noticed by a few of the first students and was not noticeable a half an hour after the taste test was underway. Many students commented that samples had a metallic aftertaste. This comment was more frequent in describing the tap water but it still had a high incidence in describing the filtered water. It also seemed that students who were used to drinking the tap water, especially from the dorms, could choose the tap from filtered correctly but had a more difficult time in deciding which one they liked better. It was also apparent that they had a higher frequency of choosing the tap water as tasting better. Those that picked sample 1 as tap water seemed to be able to tell right away and those who chose sample 2 as the tap water seemed to deliberate longer in making the decision. The students who regularly drank bottled water instead of tap water seemed to be able to tell the difference quickly.

The survey was taken during lunch hours in the lobby of Prothro Commons. Some students had eaten lunch before taking the taste test, others had not. A few students were concerned that there ability to distinguish between the two samples would be affected since they had just eaten, especially after eating foods with strong aftertastes. This fact did not seem to have any affect on the outcome of the survey and is noted only because it was of concern to the students participating in the survey.

A few students thanked us for conducting the survey in hopes that some improvement in the taste of Sweet Briar's water would be made. Many were anxious to find out if they were right or wrong in choosing the tap or filtered (questions 3 and 4) especially if they had trouble in deciding which was which. Many were also interested to find how the survey was going in general and said they would look for the final results on Earth Day.

Students consume a lot of bottled water. One would expect this consumption to decrease if the water from the dorms tasted better. The major question that has arisen from the results of the survey was whether or not it would be economically feasible to put filters on the dorm water fountains. A calculated estimate indicates that for $1.32 per student per year, water filters could be installed in the dorm water fountains. The basis of this calculation is a cost of $79.00 per filter, a three-year life of each filter (3 yr. warranty, so may actually be an underestimate of lifetime of filter); 30 water fountains in the dorms, and an average of 600 students. The filters could be installed easily and less costly as each dorm is renovated. It seems worthwhile to bring this possibility before the Student Government Association and the Renovations Committee.

### Water Quality: Sewage Treatment Plant

Once Sweet Briar has used water, where do the sewers lead? The Renewable Resources Management class visited the Amherst Sewage Treatment plant. It was with considerable trepidation that students disembarked from the Sweet Briar van. But it was less than a minute before there were soft murmurs of, "It doesn't smell here." That's because of the excellent management of the treatment plant and the regulation of oxygen so that the system does not go into anaerobic conditions. The sewage treatment plant treats about 200,000 gallons per day which services the municipal (no industrial) wastes of about 1200 people and about 550 connections. Heavy solids are filtered and ground when raw sewage enters the plant (Photo. 5-9). These solid wastes are transferred to garbage cans (Photo. 5-10) and then to the landfill. (See Chapter 10.) An ultrasonic meter measures the flow rate (Photo 5-11). Activated sludge containing bacteria which digest organic wastes is added to the sewage. Removal of the organic wastes reduces the biological oxygen demand, thus insuring that the sewage will not deplete the oxygen of the stream which it eventually enters. Aerators put oxygen in the water and prevent anaerobic conditions (Photo. 5-12). Skimmers remove grease, which is one of the most difficult wastes to treat (Photo. 5-13). (We can help by not pouring grease down the sink!) Chlorine is used to kill disease-causing bacteria (Photo. 5-14). Sodium metathiosulfate is used to deactivate the chlorine (Photo. 5-15). And the water is contributed to Rutledge Creek, which flows into the Buffalo River and ultimately Chesapeake Bay. The sewage treatment process takes incoming sewage with a BOD (Biological Oxygen Demand) of 120-150 mg/l and reduces it to 13.7 mg/l. This is a secondary treatment plant. A tertiary sewage treatment plant, which essentially produces drinkable water, would cost a rather high $600,000, which is not economically feasible at this time.

Photo. 5-9. Amherst Sewage Treatment Plant. When raw sewage enters the plant, heavy solids are filtered and ground.

Photo. 5-10. Solids to Landfill. Heavy solids are collected in trash cans and ultimately hauled to the landfill.

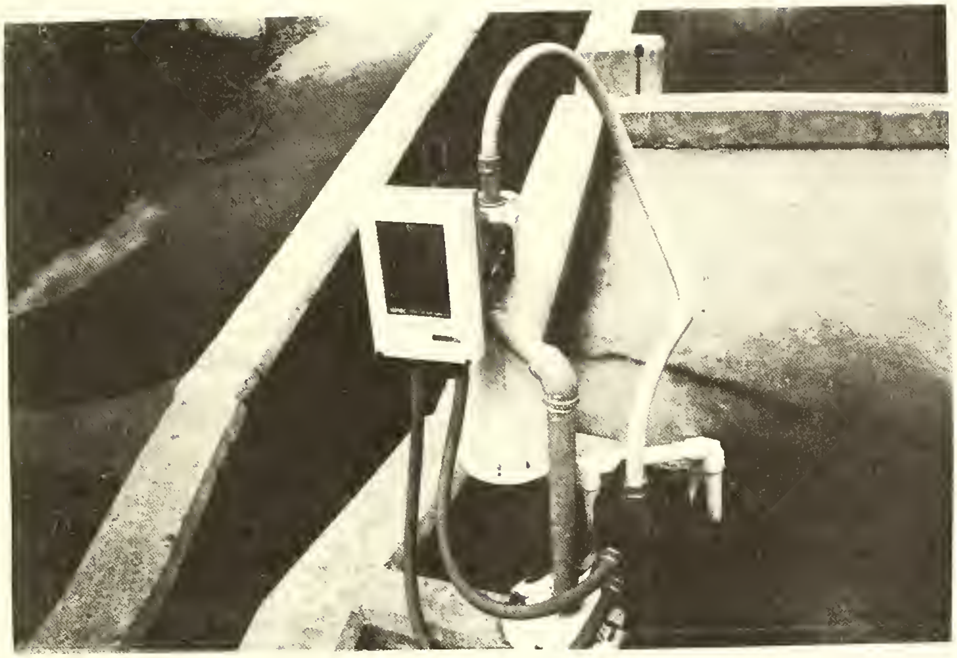

Photo. 5-11. Ultrasonic Meter. Rate of water flow is measured.

Photo. 5-12. Aerators. Oxygen added from the atmosphere prevents the creation of anaerobic conditions.

Photo. 5-13. Skimmer. The skimmer removes grease, one of the sewage treatment's plants biggest problems.

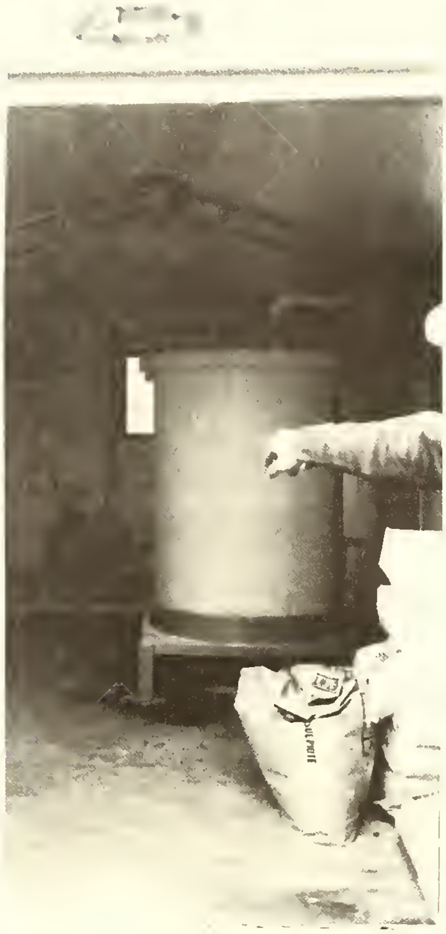

Photo. 5-14 (left). Chlorine. Chlorine is added to kill disease-causing bacteria.

Photo. 5-15 (right). Sodium Metathiosulfate. This chemical is added to deactivate the chlorine.

## The Future

At this point, the state of the quantity and quality of Sweet Briar's water supply is good. It is important to remember that the quality of Sweet Briar's water can be affected by runoff from agricultural lands and by air pollution. It is important to keep updated on pesticide use. Fortunately, we have easy access to the research from Blacksburg ("National Pesticide Research" 5). Carroll Curtis, one of Sweet Briar's alumna who heads up a project for the Virginia Institute of Marine Sciences, recently described some research which is looking at the differing effects that woods and grasslands have as buffers for water systems. Dr. Edwards has pointed out that woods tend to act as better filtering systems, but they also seem to use up more of the water supply than grasslands. Should the demand for water at Sweet Briar increase substantially (for instance because of summer programs or future growth), this type of research would be important to consult. It is also important to remember that the use of hot water directly connects with the amount of coal burned by our power plant, which in turn affects air quality. It would behoove Sweet Briar in its plans for the future to remember that water is a renewable resource only if it is used on a sustainable yield basis and its quality is protected.

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# CHAPTER 6

# LAND: FORESTS

by Elaine Barksdale

## Introduction

Sweet Briar College is fortunate to be blessed with approximately 3,300 acres of land containing an abundance of magnificent forests. (Photo. 6-1). Much of the area is in second-growth woodland of varying ages, and some areas are old enough to be approaching their original condition of climax deciduous forest. In A Sierra Club Naturalists Guide by Michael A. Godfrey, Sweet Briar is said to be the best-developed tract of its type in the Piedmont. Sweet Briar's forests offer opportunities for recreation, contain unique sanctuaries, and provide 100 acres of managed woodlots.

## Recreation

Forest recreation is an important aspect of the Sweet Briar forests. In the past and continuing into the present, riding trails have been a major part of Sweet Briar's recreational opportunities. In addition to the riders using these trails, many people jog, hike, bike, and sometimes even cross-country ski through these trails. Sweet Briar also maintains an outing cabin, boathouse, and picnic and camping areas for more recreational activities. Sweet Briar's future plans for the recreational areas are to ban all motor vehicles from these areas except the boathouse parking lot. Ms. Jennifer Crispen hopes to establish nature trails with maps and wildlife information for further educational purposes.

Maintenance is necessary to keep recreational opportunities available. Ms. Keedie Grones of the Rogers Riding Center manages the upkeep of the trails. Upkeep of the trails entails keeping the entrances clear, keeping the trails themselves clear of fallen debris, and providing a safe environment for the users of the trails. If a fallen tree obstructs passage, it is only cut to the width of the trail as opposed to removing the entire tree. Sweet Briar uses this method for clearing the trails to keep them as natural as possible. Boggy areas are also periodically filled. Present concerns for the recreational trails are erosion problems, clear entrances, the need for bridges over some boggy areas and streams, trash control, trespassing control, and better marked trails. Progress is being made to correct these concerns. (Crispen)

Photo. 6-1 (left). Sweet Briar Forest

Photo. 6-2 (below). Dr. Edwards, Professor of Ecology, discusses the sanctuaries with Environmental Studies students.

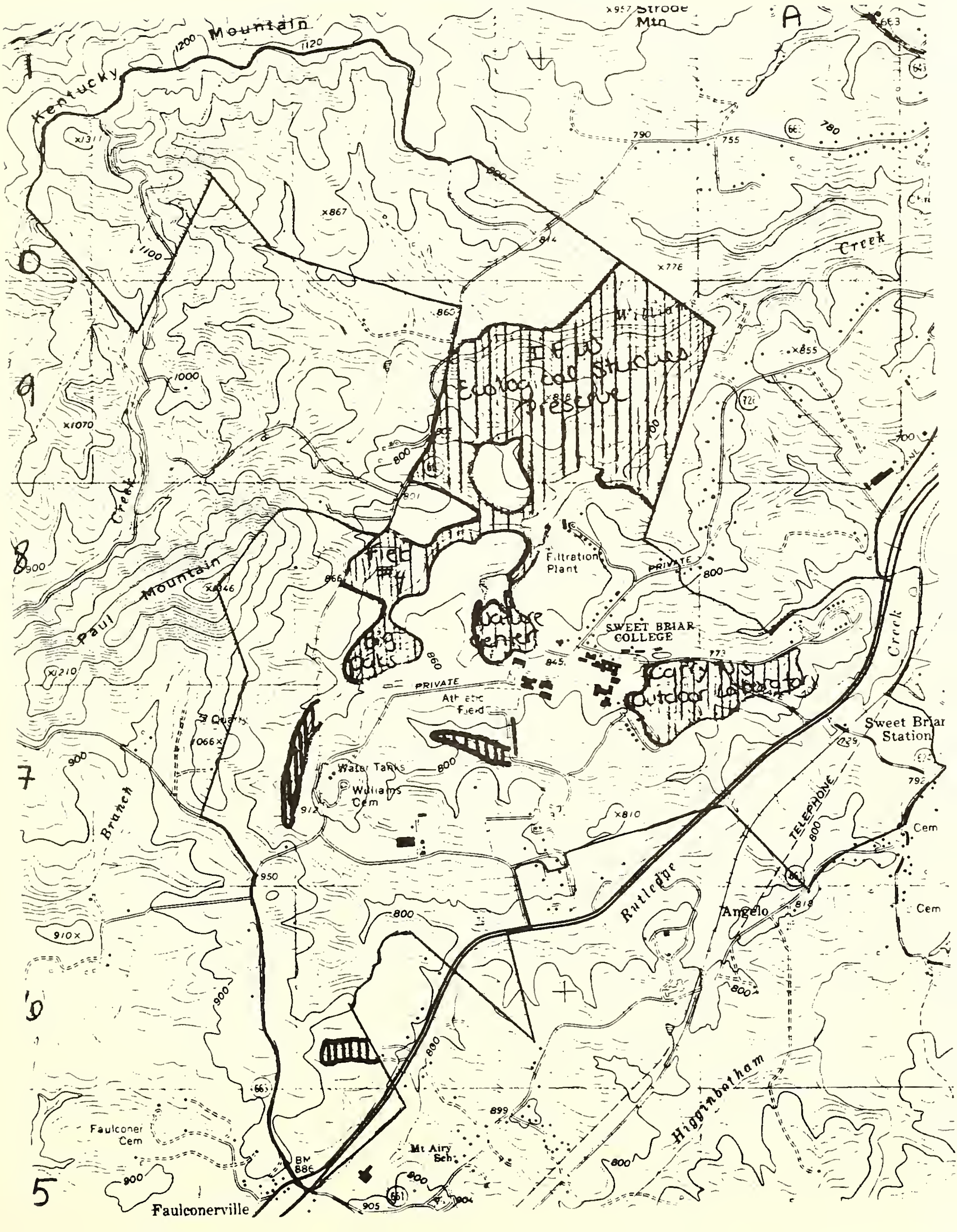
## Sanctuaries

The value of Sweet Briar's forests go considerably beyond recreational use. Sweet Briar's woodlands have a transcendent aesthetic and religious value to be enjoyed by all who venture into them. They offer a wide variety of flora and fauna. Squirrels, barred owls, pileated woodpeckers, wild turkeys, white-tail deer, snakes, beavers, raccoons, and opossums may be seen under the plush green springtime canopies.

Old Growth, as defined by the Forest Service, are forests of trees roughly 200 years and older. Sweet Briar College is unique and fortunate in that it has nine different sanctuaries with many of them containing old growth forests dating back to the 1500s. (See Figure 6-1.) Old growth forests are considered to be one of the most complex ecosystems on the earth Thay perform many significant ecological functions. They moderate climate, create soil, break down pollutants, provide medicines, prevent erosion, and provide habitat for many animals and insects that cannot survive anywhere else. They also convert carbon dioxide to oxygen, an important balance to greenhouse gas production (Chapter 3) and a major reason for wolrdwide tree-planting efforts. Old growth forests are moist enough to protect themselves against fire and floods, and produce some of the world's purest water. In the spring and summer Sweet Briar's forest floors are scattered with fourteen different species of orchids, and the once uncommon red-headed woodpecker now nests in the sanctuary's trees.

Sweet Briar's nine nature sanctuaries, which are supposed to enjoy completely protected status, have been established to be used by the faculty and students for ecological studies under natural conditions. (Edwards, "Pattern of Ecological...") The nine sanctuaries are: 1) Indiana Fletcher Williams Ecological Study Area; 2) Water Quality Field (Field #4) Ecological Study Area; 3) Big Oaks Woodland 4) Nature Center; 5) Carry Nature Sanctuary Outdoor Laboratory; 6) Scenic Stream Preserve; 7) Princess Pine Preserve; 8) White-Crowned Sparrow Hedgerow; and 9) Winter Bird Preserve. In the past these sanctuaries have been used by Sweet Briar faculty and students during the school year and for many summer courses in ecology, zoology, and ornithology. Dr. Radford and his students from the University of North Carolina have conducted important research in Sweet Briar's sanctuaries. Today Dr. Edwards and other members of the biology department spend class in the sanctuaries conducting research and educational activities (Edwards; Photo. 6-2.). Also, Sweet Briar has proposed to add additional sanctuary acreage. Larger sanctuaries are more valuable and require less maintenance. The sanctuaries are described in individual detail by Dr. Edwards in "Pattern of Ecological.Studies at Sweet Briar."

Figure 6-1. Sweet Briar Sanctuaries



The Carry Nature Sanctuary Outdoor Laboratory was the first nature sanctuary established. It was established by Mr. and Mrs. J. C. Carry in memory of their son Charles William Carry in 1958. With a ten acre addition in 1966, the sanctuary now encompasses 45 acres located mostly on the south side of the main entrance to Sweet Briar. This sanctuary most closely resembles the primeval forest, and is dominated by large white oak, black gum, hickory, beech, tulip poplar, and red oak. Dogwoods are abundant in addition to the diversity of herbaceous flowering plants including nine of the fourteen native orchid species. Despite this sanctuary's success as the most typical Oak-Hickory forest for miles around, the Carry Nature Sanctuary Outdoor Laboratory has been changed by the negative effects of a hurricane, power lines, roads, an old dump, a main sewer line, and scattered trash.

The Nature Center, located just north of the Guion Science Building, was the second sanctuary area to be established. This 11 acre woodland contains large white oak, tulip poplar, black gum, hickory, and many dogwoods on the lower levels. The Nature Center also contains a small woodland area with a creek bottom once grazed by cattle that is now fenced off and is being developed to show the recovery stages toward a mature forest. Because this area is small, encroachments from the edges of the sanctuary, widening horse-trails, and denuding of the lake's bank by fishermen severely effect the Nature Center's total natural state.

Somewhat later, the 15 acre Big Oaks Woodland area was established along the main tributary stream of Sweet Briar Lake. This area was named for the large chestnut oaks and red oaks that are now protected. In the early 1970s a three acre plot of woodland containing the largest white oak tree (14 feet in circumference) on Sweet Briar's property was added to the Big Oaks Woodland area making the sanctuaries name even more relevant. Because the area is now fenced off, the surrounding ground is quickly recovering from previous cattle damage. In addition to the great oaks, beech drops, fire pink, white snakeroot, and an occasional adder's mouth orchid thrive here.

The fourth and largest sanctuary established was the Indiana Fletcher Williams Ecological Studies Preserve. It was established in about 1968, and consists of 250 acres of mostly second-growth woodland. The area includes pure pine, mixed pine and hardwoods, heavily cut-over hardwoods, and areas recovering from pasture status. chestnut oak, Spanish oak, Virginia pine, hickory, beech, an abundance of dogwood, pipsissewa, running cedar, and pink ladyslippers are the noted plant types. Also the ruffed grouse, woodcock, pileated woodpecker, great horned owl, and barred owl make their home in this diverse sanctuary.

The fifth area established as a sanctuary in 1969 was the Water Quality Ecological Study Area or what we call today the Ecology Field. Until 1969, when natural regrowth was allowed to occur, this field was 35 acres of pasture. Since 1969, Sweet Briar students have been able to watch this field naturally evolve into the beginnings of a woodland area. This evolution however, is occurring at a very slow pace probably due to the lush pasture grass which makes it difficult for seeds to reach the soil. The main tributary of the Sweet Briar Lake was bordered by large trees and the border continues to widen today. Redtop, wild rye, and timothy are the predominant pasture grasses. Also other vegetation such as coralberry, blackberry, wild rose, red cedar, Ailanthus , and black locust grows abundantly here. Most of the wildlife consists of groundhogs, field mice, deer, bluebirds, and meadowlarks.

Understanding the need to protect Sweet Briar's water supply, the Scenic Stream Preserve was established as an area of approximately 100 feet on each side of Sweet Briar Lake's longest inlet stream. This area is a sanctuary and a water quality buffer strip. The area excludes a short portion that runs through pastureland in order to accommodate the cows with drinking water. The Scenic Stream Preserve is about three kilometers long and consists of tulip poplars, black oak, hickory, wild cherry, and alders.

In 1971, a land-use plan was agreed upon establishing protection over three new areas. First, the protection of a half-acre in Fern Woodland between the Rogers Riding Center and Faulconerville was established for a large patch of princess pine. This area is called the Princess Pine Preserve. The second and third preserves were established south of the athletic field to accommodate the favorite wintering ground of the white-crowned sparrow. The second area is called the White-crowned Sparrow Hedgerow, and the third area is called the Winter Bird Preserve.

In addition to sanctuaries providing protection for its inhabitants, they also aid in the important ecological functions of improving air and water quality. An immature developing forest produces a net amount of oxygen which assists in global recycling of water, carbon, and nitrogen. Forests also help control climate, temperature, humidity and rainfall. By establishing the Scenic Stream Preserve, Sweet Briar is improving the quality of our water. The buffer of forest land will help stabilize the stream flow and keep a uniform lake level. Also the buffer of forest will help to filter out major pollutants such as nitrogen and phosphorus found naturally in the environment and in chemical fertilizers (U.S. Fish and Wildlife Service).

## Managed Woodlots

Sweet Briar's abundance of forest land enables the college to maintain managed woodlots for profit. Sweet Briar is currently using 100 acres of land for the production of timber. There are two types of silviculture management systems, and Sweet Briar uses both systems. The first type of management system is even-aged management which involves clear cutting, shelterwood cutting, and seed tree cutting. Clear cutting removes all trees larger than one inch in diameter from a specific area, except trees reserved for special purposes. Shelterwood cutting is removing 40% to 60% of the trees while allowing new trees to become established in partial sunlight under the shelter of the remaining older trees. And seed tree cutting is the removal of most of the trees in one cut, leaving only a few well-spaced good seed producers over the area. The second type of management system is uneven-aged management which involves group selection and individual tree selection. Group selection is the cutting of trees in one-quarter to two acre sizes in order to create large openings for regenerating trees which require partial sunlight. Individual tree selection is selecting various sizes of trees to create small openings for the establishment of shade-tolerant species.

Sweet Briar has a forest management plan prepared by Don McElwee in June, 1985 that is designed for the present and future decisions concerning the general productivity of Sweet Briar's timber. The report separates the total land ownership into four unique tracts and discusses each tract individually. The four tracts are: 1) The Main Tract; 2) Mt. St. Angelo Tract; 3) Merrywood Tract; and 4) Bear Mountain Tract. Sweet Briar's actual timber harvesting only occurs on the Wilshire Tract which lies inside the Main Tract and slightly extends into other tracts. The Wilshire Tract is named after the land owner from whom Sweet Briar purchased the land. The first harvest occurred in 1938 with the cutting of existing timber and was then replanted. The replanted timber was again harvested and replanted in the Spring of 1990 after 50 years, making this the first land that has undergone one complete rotation. In 1958 more old farm fields were cleared for pulpwood and replanted with loblolly pine. Since then the field has undergone two shelterwood cuttings and is about ready to be completely harvested. Sweet Briar's future plans are to continue with a 50 year harvesting rotation over the entire 100 acres (Swift).

## Future

Sweet Briar's abundance of woodland area makes this a very unique and special place filled with recreation, education, ecologic,and economic opportunities. Past and future land use decisions reflect recognition of these values and the trade-off's among them. With commitments to multiple use of its forests, Sweet Briar is in a particularly sensitive position to consider its policies regarding paper use. Would it be possible to charge by the page rather than by the copy in order to encourage xeroxing on both sides of the paper? Would it be possible to use manilla envelopes which can be used 60 times, rather than the typical 6 or so times, for intracampus mail? Does it make sense to consider the purchase of recycled paper? One student began a preliminary cost/benefit analysis of this question. (See Appendix D.) In land use and resource policy decisions, people need to remember the mission of Sweet Briar College: the education of young women to prepare them to take on responsible, active lives in their environments.

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*Contact Don McElwee for more Sweet Briar forest information.

# CHAPTER 7
# LAND: AGRICULTURE (CROPLANDS) AND RIDING
by Ulrike Fischer

## Agriculture Worldwide - Alarming Trends

A major worldwide agricultural trend is cropland loss because of increasing urbanization, soil degradation, and soil erosion. Annual erosion rates for agricultural land throughout the world are 18 to 100 times the natural renewal rate. At this rate the world is losing about 7 % of its topsoil from potential cropland each decade. The amount of topsoil washing and blowing into the world's rivers, lakes, and oceans each year would fill a train of freight cars long enough to encircle the planet 150 times! (Miller 222). Other trends include fertile topsoil loss, desertification, drinking water contamination, fertilizer-induced eutrophication of streams, rivers and lakes, and food contamination by pesticides that threatens the health of consumers.

With a growing world population and higher yields in agriculture being the only means of feeding this growing population, new techniques of agricultural production have been introduced that have completely changed the image of agriculture. (See Boyd/McGrath 10-18 for government programs, federal legislation, changes in policies and innovative programs.) The traditional family farm that not all too long ago used to be the standard, has given way to agro-industry largely backed by worldwide corporations and a powerful chemical industry. Thus, the use of inorganic commercial fertilizers and pesticides throughout the world increased almost tenfold between 1950 and 1989. Intensified agriculture has made a tremendous rise in agricultural production possible, not only in absolute terms, but also per capita. Mechanization has reduced the labor input but, according to several authors, it has at the same time brought the system out of balance, leading to the detrimental effects mentioned above. Further, such agriculture is heavily dependent on nonrenewable energy resources.

## Agriculture in the United States

Industrialized methods of agricultural production have, especially in the Midwest, lead to groundwater contamination. An erosion rate of five tons per acre per year amounts to a loss of about 2.54 centimeters (one inch) every thirty years. The natural process of topsoil replacement takes place at an average rate of one inch each 500 years (Miller 223). In the United States, soil erosion of cropland is worst in the Corn Belt and the Northern Plains. In the year 1977, the soil loss amounted to almost two billion tons! Enough topsoil erodes away every single day in the Unites States to fill a line of dump trucks 3, 500 miles long (Miller 225).

If these are the trends, what can be done ?

## Conservation Farming: Sustainable Agriculture

The key word in the literature in this field is “conservation”: conservation of the soil and water resources and, in the end, the conservation of public health through non-contaminated food and a livable environment. Not all of the techniques of ‘sustainable’, environmentally safe and non-abusive, farming proposed to farmers today are revolutionary or ‘high-tech’. Many of them have been known for a long time and only seem to have been forgotten in the process of the industrialization of agriculture. Industrialized agriculture has been supported by federal agricultural policies which reward increased production and thus often encourage the misuse of resources. This trend is recognized by huge machinery demanding huge fields with straight rows of crops, no place for windbreaks or terracing, and residues left on fields considered a sign of sloppy farming.

There are many rediscovered sustainable farming practices. The combination of animal farming and crop farming is ecologically sound, encouraging nature's recycling: animals feed on the crops and the cropland can be fertilized with animal manure. Crop rotation alternates nutrient-demanding crops like soybeans and corn with nutrient-restoring crops like clover, alfalfa, rye, oats and winter wheat that are grown and plowed under as green manure to provide the soil with humus. Strip cropping alternates strips of row crops and cover crops. Appropriate timing of the planting season in itself can do a lot to reduce the proliferation of weeds and insects. Contour plowing along contour lines instead of across them reduces soil erosion. Windbreaks, shelterbelts and buffer zones hold soil, foster moisture retention, protect water supplies and create living space for wildlife. Finally, no-till farming where the soil is not plowed after every planting season but is only ridged to provide a seed bed, also helps prevent soil erosion (Miller 226-228).

These conservation measures go together with "Integrated Pest Management" defined by President Jimmy Carter as “a systems approach to reduce pest damage to tolerable levels through a variety of techniques, including predators and parasites, genetically resistant hosts, natural environmental modifications, and when necessary and appropriate, chemical pesticides” (Hoy/Herzog 42). Some methods applied in Integrated Pest Management are: crop rotation (again), planting hedges around fields to provide habitats for natural enemies of insects that might damage the crops, and proper timing of planting and polycultures (Miller 558). Additionally, a variety of cultivation measures and biological measures, such as genetic engineering, are used. Long-term studies have shown that these alternative techniques pay off economically as well as environmentally (Risch 568-570) when the follow-up costs of the heavy use of chemical pest control ('externalities') are taken into account.

After this short look at trends in agriculture, a closer look at Sweet Briar Farming as well as the operation of the Rogers Riding Center might provide further insights. The following information about Sweet Briar Farming comes from the answers to a questionnaire and several follow-up interviews with Jan Osinga, manager of the Sweet Briar Farm (Appendix E-3).

## Sweet Briar Agriculture: A Brief History

Sweet Briar College was established at the beginning of the twentieth century on the grounds of a self-sufficient plantation. That is why the Sweet Briar Farm was involved, until the mid-nineteen sixties, in a large variety of agricultural activities that produced the food for the college community. In addition to the dairy operation and crop farming, beef cattle, poultry, hares, sheep, pigs and orchards were part of Sweet Briar's agricultural practices until the mid-fifties. Gradually, the technology that was used in these fields of Sweet Briar's agricultural production became out-dated. Instead of investing capital in all of these and maintaining this diversity at a high expense, specialization was chosen. The dairy herd was augmented from about forty to sixty-five milking cows. The poultry, hares, sheep and pigs had no more place at Sweet Briar. In 1957, the beef herd was sold. The orchard between the train station and the green barn on the road towards the riding center was bull-dozed. (It serves today as grazing land for cattle).

## Farm Operations Today

The Sweet Briar Farm occupies about 900 acres. Half of it is used for permanent pasture for the cows (Photo. 7-1). The remainder is used for crop farming of corn, barley and hay that is used entirely for cow feed. No crops are sold; rather, extra feed in the form of small grain, a concentrated feed with a protein content of 16 %, is annually purchased for about $150,000.

Photo. 7-1. Sweet Briar Pasture

Photo. 7-2. Sweet Briar Cropland. Contour plowing and crop rotation are practiced here.

## Animal Farming

The cow herd consists of 425 animals of which Sweet Briar's joggers and walkers on the dairy route usually see only the milking herd: 170 Holstein black and whites. The total Sweet Briar herd also includes 150 herd replacement heifers and 105 Holstein steers (beef cattle) that are "off campus" at the Mount St. Angelo farm across Route 29.

## Pasture

The dairy cattle are fed all year round. The pasture comes as a bonus and a place to live. Since the dairy cows do not solely depend on the grass from the pastures, overgrazing is prevented. The ratio between the land available for pastures and the number of cows is about one cow per acre.

## Crop Farming

The Sweet Briar Farm's crop farming utilizes about 350 acres (Photo. 7-2). A six year rotation system is recommended by the Soil and Water Conservation Service. On the land used for crop farming, corn (130 acres in 1990), barley (40 acres) and hay (125 acres) are grown in a two year - one year - three year cycle: two years of corn are followed by one year of barley and three years of hay. In addition to these crops, approximately 7 acres of alfalfa (lucerne) and 50 acres of rye are grown as winter cover crops that are harvested for hay and for silage in the spring. Annual harvests amount to 1800 tons of corn silage and 17,000 bales of hay (2 1/2 tons per acre) for winter feed.

In economic terms, the Sweet Briar Farm has been in the black since 1965 and today makes an income of about $500,000 a year with annual expenditures almost equalizing this amount. Just to give the reader an idea of prices for agricultural production: one ton of corn silage is worth $25. One ton of hay costs $65 and a bushel of grain (about 35 liters) $2.50.

How is this production achieved ?

## Soil Conservation Planning

The first step in working out a farming concept is to look at the soils available. In the assessment of soil quality farmers are assisted by the U.S. Department of Agriculture's Soil Conservation Service. The agrarian engineers of this service work out a soil map (see Osinga's map, Appendix E-1, and Table I) which encodes slope, erosion phase and soil type. Slope phases range from A (nearly level) to B (gently sloping), C (Sloping), D (strongly sloping), E (moderately steep), and F (steep). The predominant slope classes are B and C with D and E occurring and even reaching up to F in some of the slopes on Paul Mountain. Erosion phases range from overwash (+), to slight (1), moderate (2), severe (3), and gullied land (9). The ideal combination of the slope and erosion phase would thus be A +. The dominant soil type at Sweet Briar is definitely loam, reaching from fine sandy loam to clay loam, mixed alluvial soil. The soil interpretation (see Appendix E-1, Table II) is based on these soil qualifications.

The soil interpretation for cropland, hayland and pasture classifies the soil categories of the soil map according to capability classes from I (few limitations to soil usage ) to VIII (limitations which prevent the land's use for commercial plant production and restrict their use to recreation, wildlife, water supply and aesthetic purposes). Categories I to IV are considered to be 'suited for cultivation and other uses'. They have been established according to limitations which reduce the choice of plants and require moderate, careful or special management. Categories V to VIII are land 'limited in uses - generally not suited for cultivation'. These soils have limitations which make them suited 'only for pasture, woodland, or wildlife food and cover.'

Possible limitations are a lack of soil depth, lack of fertility, different degrees of vulnerability to water and wind erosion, top soil loss, slopes (which favor erosion), lack of drain for precipitation, depending on the permeability of the subsoil and the moisture-holding capacity or high salinity or alkalinity. (For a thorough identification of different limitations in land capability classification see Sampson, Appendix A, Land Capability Classification, 338-344).

A comparable soil interpretation has been made for the Sweet Briar woodland. (See Appendix E-1, Table III). It gives indications on estimated growth rates for different kinds of trees: several sorts of pines, oaks, and poplars.) In the section on 'limitations for use', seedling mortality, plant competition, equipment limitation, erosion hazard and windthrow are evaluated and predicted. The scale ranges from '1' (high seedling survival, no special problem with plant competition, equipment can be used all year round, no erosion or windthrow problem) to '3' (less than 50 % seedling survival, site preparation necessary in order to prevent plant competition, wet slopes or erosion hazards that prevent the use of heavy equipment, chances of windthrow because of the water table or soil restrictions (Appendix E-1, Table IV ).

## Crop Rotation

After having evaluated soil quality and limitations, a specially designed conservation plan was set up for Sweet Briar in cooperation with the County Soil and Conservation Service. The last conservation plan originated in 1984 and covers the years 1984 until

1990. (See Osigna's map and Appendix E-1,Table V.) The cropland of the Sweet Briar Farm was divided into twenty-two fields (four to thirty-seven acres) which all appear on the map. All of them carry a number (Field No. 2 to 60 ) and underneath this number the size of the field is given in acres. These field numbers correspond to those in the far left column of the cropland schedule. Most of the fields have, of course, other 'names' according to their location. The second column ('Use') enumerates uses like cropland, natural area or permanent hay. The fields reserved for permanent hay or natural areas have no crop rotation schedule. Most fields are divided into several sections (a,b,c,d,e,f etc. - see third column). These are the different strips that are cultivated in each field. The strip-farming fields on the map are, for example, fields No. 2 and 5 in the very north of the Sweet Briar property or field No. 40 south of the riding center. The columns underneath the years 1984 until 1990 show which crop has been or is to be grown on the different strips in every single year. Individual adjustments are made to the rotation schedule where the soil permits or needs different planting (see field No. 19). Alfalfa is grown to be mowed for hay; rye serves as a soil cover during the winter. The strips in every field provide a crop alternation within the fields (in 1990 field No. 2 strip a will be planted with barley, strip b with corn and strip c with barley). The strips of permanent hay or natural areas are to be found on the limits of several fields. They function as stopper zones for soil erosion.

## Contour Farming

Another technique used to prevent soil erosion at Sweet Briar is contour farming..Rather than huge squares, fields are shaped along the contour lines of the terrain. This does not make the task of the farmer an easy one, since large machinery cannot be used on these small, irregularly shaped and rounded fields. The contour lines of the landscape are determined by engineers in a land survey. Farming along and not across the contour lines prevents erosion by keeping water from running downhill. The safest erosion prevention measure is, of course, not to use marginal lands for crop farming at all, but to convert them to uses like pasture, woodland or wildlife areas. This is why the steep slopes on Paul Mountain are covered with forest and why most of the pastures are situated on slopes. Land use practices need to be guided by the characteristics of the land.

## No-till Farming

In the cropland schedule, 'corn (S)' means 'no-till corn planted in grass sod.' This field is not plowed, but the corn seeds are inserted into rills. This keeps the topsoil from being turned over by the plowing and leaves the soil structure as well as the living organisms in the soil intact. However, this method makes the use of herbicides necessary to clear the field from the residues of the crop planted there before that might prevent the growth of the corn and to prevent weeds from competing with the corn for soil nutrients. The herbicides used at Sweet Briar in this process of sod killing are Eraxmone and Paraquart, in a quantity of two pounds per acre.

### Soil Testing: Fertilizers

Fertilizers are applied according to the results of regular soil testing. (For an example of a soil test report, see Appendix E-1, Table VI.) The report is divided into three parts. The history of the sampled area includes the number of the field, acreage, soil type, slope, the last crop planted, the yield produced in tons per acre, and the last application of fertilizers in pounds per acre. Secondly, lab test results including soil pH and the presence of minerals in pounds per acre are reported. Finally, from this information, come recommendations for fertilizer and limestone applications, in this case for corn silage (conventional till) and hay.

The chemical, inorganic fertilizers used are nitrogen (N), phosphorus (P2O5), potassium (K20) and trace minerals . On some fields, lime is applied to regulate the pH. (See handwritten notes in Appendix E-1, Table V, fields no. 17,18 and in 1988, fields no. 29, 40 and 42 in 1987, for example.)

The soil test, then, does not merely give information about soil quality, but actually assists the farmer in preparing the soil for specific crops by applying different amounts of chemical fertilizers. (For example, corn needs a pH of at least 6, whereas hay can tolerate a lower pH.)

In addition to the inorganic fertilizers, organic fertilizer is applied on the crop fields in the form of cow manure from the dairy that is used 100% for this purpose. Another form of fertilizing the cropland is the planting of alfalfa (lucerne) that not only provides a winter cover, but is plowed under as 'green manure' and provides the soil with nitrogen thanks to its ability as a legume to transform atmospheric nitrogen gas into nitrates. Nitrogen fixation is carried out by rhizobium bacteria living in small swellings called nodules on the roots of the alfalfa plant as well as on the roots of other legumes like clover, peas or beans that can also be used as green manure (Miller 95).

### Pesticides

As mentioned above, 'no-till farming' makes the use of herbicides necessary. In addition to 'Eraxmone' and 'Paraquart' that are used for sod killing, the insecticide 'Furidane' in a quantity of six pounds per acre is applied on fields used in no-till farming.

The only insect that has to be fought is the army worm that has invaded fields across from Route 29 before. Strangely enough, this worm very often appear near traffic ways such as Route 29. On the alfalfa fields the weed-killer 'Princep' is used in a quantity of two pounds per acre to kill chickweed. Another herbicide used in Sweet Briar farming is a product by the name of 'Bullet' (a mixture of 50% Atrazin and 50% Laso). The amount used is one gallon per acre.

## Protection of Water Supplies

In order to protect the Sweet Briar watershed from fertilizer run-off and overload by eroded soils, buffer zones have been set aside from crop farming. The land around the upper and the lower lake is either unmanaged wildlife land, forest, or hayland with minimal fertilization to have the lowest possible impact on the water quality (Chapter 5).

## Sustainability of Sweet Briar Farming

The general practices of Sweet Briar Farming are environmentally sound. In cooperation with the Soil and Water Conservation Service and the Agriculture Stabilization and Conservation Service, erosion control plans have been elaborated that do the utmost to prevent soil erosion. It would be difficult to determine where on a scale from conventional farming to low input/organic farming Sweet Briar could be placed. This is all the more difficult as these categories cannot strictly be separated from each other. To some degree Sweet Briar farming is conventional (use of chemical fertilizers and pesticides), but the soil conservation measures like crop rotation, contour farming, no-till farming and the water protection measures are examples of sustainable farming. It is particularly impressive that these techniques have been used for the last forty years. It is not without reason that farm manager Jan Y.Osinga has been awarded the Outstanding Conservation Cooperation Award for Amherst County. In part, Sweet Briar farming could be called organic since cow manure is applied as an organic fertilizer and alfalfa is grown as green manure to be plowed under before crop planting begins.

Farm Manager Jan Y. Osinga defines his mission as follows: "We try to operate a healthy surrounding area. We do not go for the most money. We go for low investment and not losing money. The Sweet Briar Farm shall be an asset and not a burden."

## The Future

"We will continue with what we are doing today unless the market forces, for example the milk or the beef prices direct us into another direction," says Jan Y. Osinga. The 'market forces' are one of the determining factors of the Sweet Briar Farm's operation. They certainly do not dictate the management of the farm as much as in the case of the agro-industrial large-scale operations of the Midwest, but they do have an influence, since the purpose of the dairy is to be profit-oriented: "We are, after all, in business."

## Land-Use Trade-Off's: Sweet Briar Land-Use Plan

As mentioned above, Sweet Briar farming is generally environmentally sound. However, some minor remaining problems could be addressed. In order to evaluate some of these problems, it might be helpful to look at the Sweet Briar Land-Use Plan. (See Appendix E-2.) Adopted by the Campus Committee on Natural Resources in March, 1971, and approved by the Board of Overseers this plan was meant to be valid for three years, but was extended indefinitely in 1974. The land-use plan states that all authority over the use of Sweet Briar land rests with the Board of Overseers and that the Campus Committee on Natural Resources only makes proposals.

The proposals that concern the management of the farm operations show some conflicts between the land required by the proponents of Environmental Studies and Biology for Ecological Studies Preserves and the requirements of the farm operation (land requirements to produce sufficient amounts of crops to feed the cattle herd as well as being able to reach fields with farming equipment. No. 3 (a) ). No. 4, 5 and 6 of the proposals call for 100 feet wide buffer zones along the small streams in order to protect water quality. The comments say that all of these buffer zones have been installed and that this required not only agreement between the proponents of the nature sanctuaries and the farm management, but also the riding center, represented by Paul Cronin, Director of Riding. Some of the trails used by Sweet Briar riders had to be re-routed to protect sanctuaries. No. 14 mentions that oak groves have successfully been fenced out of pastures.

No. 15 and 16 deal with the removal along the dairy road and the preservation beneath the hockey field of multiflora rose hedges that had to be negotiated between the proponents of wildlife preserves and the farm management.

## Remaining Problems and Possible Solutions

What are remaining environmental problems of Sweet Briar farming today? The two basic environmental concerns are erosion control and the protection of the water supply.

The major occurrence of grass loss and beginning erosion that every jogger on the dairy-route can see is the erosion in the barn lot (field No. 34 on Osinga's map) where all the milking cows pass through twice a day. There is hardly any grass left in this barn lot. The rills in the ground stem from the cows' walking behaviors. Rain water gathers in these ditches, creating a muddy field.

In addition to this, Rutledge Creek passes through the barn lot. Cows pass through the creek on their way to the dairy: they drink the water and defecate in the water. Fortunately, Rutledge Creek does not run into the Sweet Briar water supply. However, it would be a good idea to reduce this organic pollution which raises the biological oxygen demand (BOD) of the creek (Chapter 5, sewage treatment). This could easily be achieved by fencing it off and constructing a cemented way (yet to be built) close to the dairy route that would stabilize a path already in use now by water-shy cows. The erosion problem can very probably not be entirely solved, since the number of cows passing through is very high.

In the pasture (Field No. 35b), another form of cow impact can be observed. The herd instinct makes the cows walk towards the dairy in lines one behind another which creates worn-out paths. There are several of these, one beside another, and each exactly 36 inches from the next one - 36 inches being the width of the cow's belly. It is easier to approach water quality improvement by keeping cows out of the water than soil degradation. The final solution might require leveling of the field with red Virginia clay mixed with sand to provide good drainage and replanting with grass.

Water quality problems also exist in field No. 16 behind the green barn on the route to the riding center. Pastures No. 16 and 12 (see Osinga's map) are actually connected to form one immense pasture that is cut in half by what the Land-Use Plan calls the 'scenic stream'. This stream goes directly into the Lower Lake. The slope that leads down towards the stream shows heavy loss of the grass cover and beginning erosion of the sides where small gullies are forming. The bed of the stream has been enlarged at the place where the cows pass over a cement tube that is meant to drain the stream. The muddy area all around this tube might threaten the roots of some large trees standing right at this place. Between the unnumbered part of pasture No. 16 and pasture No. 12 there is another little stream that is fenced off on its northern side with a small gate in the fence. The cows pass through after having crossed the stream which is somewhat smaller than the 'scenic stream', but flows faster because of steeper terrain, thereby eroding more easily. In this case, however, the damage has been somewhat limited to one spot where there is the opening in the fence on the northern side of the stream. This is the small pass-through that the cows must use.

How could this problem be solved ? The cows must get to the water in order to drink. One option to keep them out of the stream would be to install drinking troughs on the level of the pastures that would be filled by pumps. These pumps could be run by wind and/or solar energy. A conventional car battery could be used for backup. The maintenance of these watering places would certainly be more labor-intensive than letting the cows drink out of the stream, but the environmental cause is certainly worth it since the 'scenic stream' leads directly into the lower lake. In order to prevent the soil erosion on the slope field No. 16 (leading down towards the stream) the huge pasture ground (fields No. 16, the unnumbered field west of it and No. 12) could be divided into three different pastures. The problem would be the feeding of the cows in three different fields throughout the year. At the present time the feeding of the cows in these fields is done just beside the green barn on the right side of the road towards the riding center. The centralization of the feeding has led to the loss of the covering grass near the long feeding trough. (The same loss of grass can be observed in front of the green cowshed). Installing three feeding places instead of the one presently available and splitting the cow herd up into three holds according to the size of the three different pasture grounds would be one solution. It would, of course, be more labor intensive than letting the cows pass through the streams several times a day to reach the central feeding place, but it might reduce soil erosion and protect the Sweet Briar water supply. Also, the 100 feet of unmanaged land along either side of the streams on campus could then be observed for the 'scenic stream' and for Rutledge Creek as well (if pipes leading to the watering places on the pastures could be installed).

Another place where erosion can easily be observed on campus is on field No. 15 (pasture), right of the route to the riding center, before the green cow barn. Since the Sweet Briar orchard was bulldozed in 1957, this land has served as cow pasture. Unfortunately, there are several spots where the protecting grass layer has been destroyed and where the red Virginia clay can be seen. These spots have been there for a long time and have not substantially grown over all these years. The cows stand on these places, walk through them and might cause heavier erosion. In this place reclaiming action might be required, for example by planting bushes wherever the grass layer has been destroyed (or temporarily fencing off to prevent them from being eaten or chewed on by the cows). The occurrence of grass loss with a potential for soil erosion might also be an indication that the slope is too steep to be used for pastureland. Planting trees on the whole pasture would destroy one of the nicest views of the Virginia landscape on the whole campus, but stabilizing the steep slope where grass loss has already occurred by planting bushes on it might prevent further degradation.

The last point of environmental interest that shall be mentioned as a minor problem is the eventual loss of the contour lines on field No. 19 g. At the southern end of this field the plowing lines seem to end up vertically on the dairy route instead of rounding up to go along with the contour lines.

These last two points (soil erosion in the former orchard and possible eventual loss of contour lines) are of minor environmental impact since they have not yet led to soil erosion and do not have a negative impact on water quality. The loss of grass cover, the beginning erosion in fields No. 16 and 34, and the water pollution from cows in the streams are more serious problems. Sweet Briar's Farming is environmentally doing well. If those two problems could be handled, it would be even better!

After having a short look at Sweet Briar Farming, the Riding Center shall be discussed. Information for this part of the paper has been drawn from a questionnaire answered by Keedie Grones, Manager of the Riding Center and Stables, and by Paul D. Cronin, Director of Riding at Sweet Briar College (Appendix E-4).

## Sweet Briar Riding: A Brief History

Sweet Briar Riding started in the 1920s. The horse barn was situated to the right of the entry to the campus. The white building is preserved and used as a storage facility. The Rogers Riding Center on the Dairy Route was built in 1971 on land that had been cropland. A larger facility was needed to respond to greater student enrollment and a successful instructional program. An anonymous donor made available the financial means required to set up a larger facility.

## Educational Mission of the Riding Program

In contrast to the dairy and farm operations, the Riding Center is education-oriented. Under the direction of Paul D. Cronin the riding program is a part of the Department of Physical Education and Athletics and is, thus, part of the college's curriculum. The Sweet Briar College mission statement applies to the riding program as well as to any other academic program. Besides the Sweet Briar mission statement, other goals for the Riding Program have been defined as follows:

"The Riding Program offers a strong instructional program and riding competitions in open horse shows, intercollegiate competitions, hunter trials, and hunt-meet pair racing. Other activities include fox-hunting in Virginia, and in January riding and schooling in Southern Pines, N.C., and cross-country hacking." (College Catalogue 1989-90, 93). The Riding Program offers riding classes in Position and Control, Cross Country Hacking, Jumping, Showing Hunters, and Schooling Hunters, Jumpers, Young and Problem Horses. These full offerings are backed up by more theoretical courses in Horse Science: Basic Horse Care, Farm and Stable Management, Judging Hunters, and Selecting Thoroughbreds. The riders provide one of the seven college intervarsity teams. An important objective in the instructional work is the recreational aspect. Student participation plays an important role in the operation of the Riding Center. The Student Riding Council tries to "lend spirit and leadership on a student level to the entire program." (Riding Council Manual)

## Administration / Management

The Rogers Riding Center is managed by Keedie Grones under the direction of the Director of Riding, Paul D.Cronin. Rogers Riding Center and the Sweet Briar Farm are, because of their two very different missions, run separately. The Riding Center's budget is submitted through the Dean's Office, reviewed by the faculty budget representatives, and goes through the same process as the budgets for all other educational departments, whereas the dairy and farm budget (profit-oriented) is overseen by the Vice-President and Treasurer.

The Riding Center hosts approximately fifty horses. Thirty-five of them are owned by Sweet Briar College and ridden by all students according to their riding skills. Fifteen are privately owned by Sweet Briar students. Sweet Briar horses are stable-boarded, but turned out on the paddocks for approximately one hour per day in a rotating system (one horse per paddock). Currently, two horses that are not in work live outside to save on stall bedding and labor. The stall bedding consists of peanut hulls and in some summer months of sawdust from a local lumber yard since Sweet Briar does not have a milling operation. About forty to fifty pounds of used bedding and manure are removed and piled up in an area east of the Riding Center.

## Organic and Inorganic Fertilization

The decayed peanut hulls are used as an organic fertilizer for soil improvement on the paddocks and fields, as an erosion control device, and as a seeding cover. In addition to this organic fertilizer, nitrogen fertilizer and sometimes potash or lime are applied on the fields when overseeding. The peanut hulls from the stall bedding also serve as mulch that the Grounds crew uses all around campus and excess amounts are sold to local gardeners. The money earned in this way is reinvested into the purchase of peanut hull bedding.

## Chemicals in the Stable

Chemicals used in the stable are conventional laundry soap to wash saddle pads and blankets, dish-washing soap for the horses and feed tubs, saddle soap and glycerine for cleaning the tack, and insecticides to combat flies in the stable wings (powdered poison for the food containers and fly spray on the horses). Other chemicals include the horses' medications.

## Horse Feed

The horses feed on a pelletted sweet feed and oats mixture originally formulated for the Sweet Briar Riding Center by its veterinarian and a feed company. (Today, this mixture is sold commercially, too). The fifty horses eat about forty tons of this mixture per year, supplemented by 185 tons of a good quality timothy or orchard grass hay purchased from a hay dealer in the Shenandoah Valley).

Sweet Briar horses do not eat Sweet Briar hay. This is because the Sweet Briar Farm needs the hay grown on Sweet Briar for the dairy cows and because the hay grown at Sweet Briar does not meet horses nutritional requirements. Because of the different needs of cows and horses, it is not possible to do combined ordering of feed, supplies or medications.

## Land-Use

The Riding Center is situated on approximately 60 acres of land a quarter of a mile west of the dairy. It includes the indoor arena, two wings of stables, two outdoor rings, pastures that are also used as riding grounds for training the horses, paddocks to turn them out (for grazing and in order to provide them with an opportunity to get rid of surplus energy, a strategy that greatly benefits Sweet Briar riders) as well as storage facilities for feed and material. In addition to these facilities, however, Sweet Briar's riders also use miles of trails all over campus, many of them leading through cow pastures and fields. With the Farm the Riding Center shares the use of the grazing fields: the Farm takes care of the fences, the Riding Center maintains the jumps.

For the use of the Sweet Briar campus as a riding ground, Hackers' limits have been set up based on safety and easy access for low level riders who have passed a Hacker's test proving that they can control their horse within a small group outside a ring. The Riding Council limits are an expansion of these areas for more experienced riders. The riders' limits, rules of behavior and trail policies are revised about every two years by students and faculty.

The upkeep of the existing riding trails is done by the stable staff on a 'piece meal' basis. Trails are not only maintained for riders, but also for joggers or hikers. Major clearing of the trails is done in the summer with updates done in the spring and in the fall. If a specific trail is blocked and reported as such, it is usually cleared within one week by members of the stable staff. This is a service the Riding Center provides to all members of the college community who use the trails for hiking or jogging. The Riding Center Management does not see any conflicts between these users and the horses and riders, but opposes trail use by four wheel vehicles or motorbikes (usually from off campus). The Riding Center would appreciate help with trail maintenance.

## Problems

The main problem in the land-use of the Riding Center is soil erosion that occurs in some of the steeper and worn paths and paddocks around the stable. The slope leading up to the upper ring had to be stabilized with stones. The path leading out of the West Field towards Monument Hill runs straight up the slope, thus facilitating soil erosion. The doorway areas of the paddocks as well as the lower exit of the West Field have almost all lost their grass cover. In most of the paddocks there are worn paths along the fences where the horses run.

Since the horses must be turned out, there is very little chance of preventing this soil erosion. One possibility would be to expand the Riding Center Area, creating more paddocks that would then be used less intensively. However, even at Sweet Briar space is limited and the Riding Center land-use has to compete with the land-use of the Sweet Briar Farm. Since the Farm today is not able to provide all the feed needed for the cows, it will be extremely difficult to take crop or hayland away from it in order to create further paddocks for the Riding Center. The Riding Center will, therefore, have to do with the area it occupies today.

The big advantage that the Riding Center has over the day-to-day operations of the dairy is that the use of the land varies according to the season of the year. During the academic year when operations are running at full pace, the only possibility to prevent further erosion is to discontinue use of the paddocks and grazing grounds during rainy days so that the shoed horses will not further destroy the then especially fragile grass layer. Fortunately, there are at the Riding Center periods of less heavy usage (during the summer, for example) that can be used to overseed or replant and thus reclaim damaged areas. These time periods of relative rest are also the time when nature can reclaim the trails which in part have been in use for longer than 50 years and, therefore, would need erosion control. Methods of reclaiming damaged trails would be to provide adequate drainage in muddy areas (run off troughs) or re-rout certain trails. However, this last possibility might not be feasible since in some parts of the campus, the riders compete with the land claims of the Environmental Studies and Biology Departments, who would like to see their sanctuaries undisturbed.

However, all riders should be instructed about the environmental impact that they have when riding. They should be are reminded not to use worn paths wherever this is possible and to avoid riding through muddy areas, especially at higher gates.

## Land Use Conflicts

Since the trails do not lead through cropland and since riders are strongly advised to keep off cultivated land, the major trade-offs are probably between the wildlife/natural areas and the riders who pass through. It should be noted that the wildlife is certainly less disturbed by riders than by four wheel vehicles. Apart from certain erosion problems caused by the horses on the trails, the disturbance is slight.

## Acknowledgements

At the end of this paper that hopefully has provided some new and interesting insights into the operation of the Sweet Briar Farm and the Rogers Riding Center a really special and really big **THANKS !!!** goes to Jan Y. Osinga and to Keedie Grones. Without their cooperation and readiness to answer all my questions this paper would never have come into being. A great many thanks also to Douwina Osinga for her great patience with me on the phone when I tried to ask Jan Y. Osinga "only a couple of more questions"

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# CHAPTER 8
# LAND: AGRICULTURE (DAIRY)
by Karen Hott

## Introduction

Dairying is the branch of agriculture concerned with the production of milk, cheese, butter, ice cream and associated consumer items. It is one of the leading agricultural activities in the United States, with an annual income return of $9.9 billion from the sale of milk. According to Campbell (25), "the foremost function of the dairy industry is to provide milk and milk products for man." Milk contains essential vitamins and minerals vital to life as we know it. "Along with poultry and eggs, milk constitutes the highest source of protein for human consumption" (Stufflebeam 344). Not only should we consider milk as valuable to our health, we should consider it along with the cows as producers, a renewable resource.

## The Big Picture

"Ever since the domestication of the cow, she has been an essential part of every developing, progressive society" (Campbell 26). Before there were mediums of exchange, some societies used cows for “money”. Later, images of cows appeared on coins to show wealth. Also, wealth was measured by the number of cows one possessed (Campbell 26). Milk is credited for the survival of many settlers in the New World and Jamestown following Columbus' second voyage. Some historians argue that Norwegian Vikings may have brought the first cattle to the Americas. From this time on, the dairy industry grew in the United States. Most significant growth occurred after 1840 when large cities began to develop.

"More than 90% of the world supply of milk is produced from dairy cows" (Stufflebeam 346). Other species which provide milk for human consumption are goats, water buffalo, camels, and llamas. Annual consumption of milk per person in the United States is approximately 560 pounds per person. "Trends in the per capita consumption of all milk products have shown an increase during the past few years after having shown a decrease over a period of twenty years (Stufflebeam 347).

There are approximately 11,000,000 milk cows on farms in the United States today. About 85% of all United States dairy cows are Holsteins, which produce more milk per cow than any other breed. The average size of dairy herds is about 25 cows. However, large commercial herds may have more than 1,000 cows.

## The Sweet Briar Dairy

The Sweet Briar Dairy is an essential part of the college. Not only is it the source of all milk and dairy products for the community, but it is part of an extensive network of a nationwide system. Sweet Briar College and Sweet Briar Dairy share common roots.

In the early days of Sweet Briar, the farm was a self-sufficient operation. The dairy provided the students and community with dairy products and milk. Consequently, there were "pork and lamb for the college tables supplied entirely by the farm." Orchards provided the community with fruit and lumber as well. "In those days the farm was still under the administration of the president, and the farmer had many duties directly connected with the college" (Stohlman 105). The dairy provided the college community with a valuable resource unique to Sweet Briar.

The current manager of the Sweet Briar Dairy and Farm came to Sweet Briar in 1953. Jan Osinga began as a herdsman, and by 1963 he was farm manager. He immigrated from Holland in hopes of finding a farm for his family in the United States. At this time Sweet Briar was involved in several agribusiness operations, including beef cattle production, poultry, sheep, and orchards. Their products were to feed the community, as they had been for so many years. Soon after Osinga arrived, the college made the decision to eliminate all the farm operation except the dairy (Anderson 7). "In 1957 the beef cattle were sold and the orchard was bulldozed" (Anderson 8). As mentioned in the previous chapter, this change reflected growing specialization of all occupations in this country and marked the advent of the dairy as we know it today.

The dairy's efficiency is higher than in early years. Due to technological advances, all milking records are computerized, providing information on individual cows. Larger tracts of approximately 900 acres are farmed now. There are approximately 175 lactating cows out of a herd of over 400 Holsteins (Photo. 7-1) as well as "a fully mechanized up-to-date milking parlor that can handle a dozen cows at once." "The dairy produces more than 300 gallons of milk weekly for the Sweet Briar community, authentic Dutch yogurt, and other dairy products" (Anderson 8). Surplus is sold.

## Milk Production

Lactation is a term meaning to secrete milk. For weeks after a calf is born, the dam provides milk for the newborn offspring. Since the liquid must sustain this animal, it is an excellent source of nutrients (Stufflebeam 344). "The dairy cow is an exception in that through years of selection, it has been developed into a high producer of milk" (Stufflebeam 345). Essentially, humans have altered the cows' biological systems and compete with calves for milk.

## Nutritional Value

As mentioned previously milk is an excellent source of nutrients. "One quart of milk will provide one half the daily protein needs of an adult and essentially all the calcium and riboflavin requirements" (Stufflebeam 348). The key factor in human nutrition is the quality of protein. Milk contains a variety of essential amino acids, and its protein quality stands second only to eggs. Fat content is very important and the amount can vary significantly among breeds. (Stufflebeam 349). The record for most butterfat produced in one year is held by a Holstein cow. It must also be noted that the fat content varies with age, stage of lactation, nutrition, and breeding.

## Rangelands and Grazing

Interrelationships exist between land and cows. The land quality is vital to the dairy industry. The world's three billion domesticated or ruminant animals, in turn, provide manure which fertilizes the land. It also should be noted that rangelands are "land on which the vegetation is predominantly grasses, grass-like plants, or shrubs such as sagebrush," (Miller 282) that is, land that would not be appropriate for raising crops.

Presently, however, "only about 40% of the world's rangelands are used for grazing" (Miller 283). The land is adversely suffering from degradation, conversion to irrigated cropland, overgrazing. Roots of essential plants are killed. The carrying capacity of particular herbivores are risking over-consumption of the metabolic reserve (Hinckley 45). Foraging increases a land area to become more susceptible to air, wind, and water erosion (State 215). The restoration of overgrazed land is expensive, costly, and often irreversible.

According to the Bureau of Land Management "livestock grazing is the most extensive use of the administered federal lands" (Comp 147). Reports show the damage done by overgrazing and reveal a need for change. This change will involve balancing livestock with other resources and improving degraded areas (Comp 147). If this project is carried through, carrying capacity of the land must be considered, along with basic inventory information.

## Cows and Milk: A Renewable Resource

The dairy can be viewed from a variety of vantage points, including that of renewable resource management. Technology and research have greatly altered the management of the dairy. Humans have adapted agriculture to the computer age with terrific success. From selective breeding and genetic engineering to computerized milking parlors, the dairy industry has prospered into the 1990s.

The future for the dairy industry, according to a recent article, is a bit shaky due to climate change and weather conditions. Farmers seem to be scheduling peak milk production times to coincide with seasonal price subsidies (Change 52). Shortage of fresh grass caused by the recent drought has frustrated farmers anticipating milk price fluctuations. It is interesting to point out, though uneasiness is apparent, that "cattle of all descriptions have been in strong demand, from both rearers and butchers" (Change 52). This was partly due to an increase in meat consumption, thus increasing demand for U.S. grains used as livestock feed (State 344). Dairy farms have increased in price. Manufacturers seem to want to reach their suppliers directly rather than through the mediation of a bulk buying agency (Change 52). From a consumer point of view, it appears that the small, independent farmers have the advantage over the large commercial farms.

The Sweet Briar Dairy is one of the largest and most successful on the East Coast. The dairy has seen many changes over the decades. The complex operation provides milk and related products to more than one thousand individuals in the Sweet Briar community. Its uniqueness brings it character and charm. Farm Manager, Jon Osinga's jokingly says, "A lot of people have ask me what Sweet Briar College is doing with a dairy? My reply, What is Sweet Briar Dairy doing with a college!"

## Acknowledgements

I would like to thank Mr. Jan Osinga for the tour of the dairy, as well as his historical background which lends itself so nicely to the uniqueness of the Sweet Briar Farm and Dairy. Thanks to Ann Whitley, Director of the Sweet Briar Museum for the use of materials regarding the history of Sweet Briar College and its Dairy. I consider this experience valuable both educationally and personally. Not to mention I found out exactly "what Sweet Briar College is doing with a dairy!"

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# CHAPTER 9

# LAND: PESTICIDES AND FERTILIZER USE

by Tricia Pheil

## Introduction: Pesticides

A pest is what one deems undesirable and is an interference to human activity. Pesticides, which include insecticides, herbicides, fungicides, and rodenticides, are toxic chemicals that control or destroy those things we consider to be an annoyance. Pesticides were created to improve the quality of our food, water, and home while preventing some forms of destruction such as defoliation and crop damage, and the spreading of diseases such as malaria. As Americans, we use 2.7 billion pounds of pesticides a year. 300 million pounds of that are used in our homes (gardens, lawns, and kitchens) and on golf courses (The Earth Works Group 80).

## Pesticide Effects / Regulation

Nonpoint pollution is often an effect of pesticides. Pesticides are known to contaminate our drinking water, primarily from agricultural run-off, biologically magnify in our food chains (the higher the level on the food chain, the higher the concentration of pesticides), and threaten our water and soil when improperly disposed of (U.S. EPA). What is sprayed on the plants often ends up in the soil and eventually in our water supply. Plant roots absorb pesticides, as well as nutrients, from the soil (Mott and Snyder 28).

Overexposure to pesticides can cause nerve and kidney problems, sterility, birth defects, and cancer in both animals and humans. A farmer exposed to pesticides is six times as likely to get cancer than the average citizen, and children that are exposed to large amounts of pesticides are seven times more likely to develop leukemia than other children. The Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), passed in 1982, limits human use of and exposure to pesticides. The United States Environmental Protection Agency (EPA) may ban the use of certain pesticides if they are proven to be harmful to humans and wildlife, and the Food and Drug Administration (FDA) sets standards for the amount of pesticide residue that is allowed in our food (Mott and Snyder 23, 24).

## Lawns: Dealing with Weeds and Nutrients

According to Bruce Thompson, Sweet Briar is not striving for a weed free environment. Weed control options include: 1) to fix the problem manually or to alter the environment, 2) to use chemicals sparingly, and 3) to resod every three to five years. Manually fixing a problem includes tasks such as working on the plants and flower beds, by hand, in the greenhouse. Setting the mower blades at three inches instead of two inches is an example of altering the environment. This strategy shades the grass roots so that they may conserve moisture and grow faster than weeds; the weeds do not receive sufficient sunlight among the taller grass and eventually die. Sweet Briar uses chemicals sparingly when the first option fails or is an impractical choice. Resodding costs approximately $750,000, and is therefore, is too expensive to consider. Using chemicals is more economically feasible.

A new general lawn care strategy at Sweet Briar involves the application of an organic liquid seaweed fertilizer, already used in the greenhouse on plants. The seaweed mixture is a natural growth stimulant with low nitrates and phosphates. Applied directly to the grass with a sprayer, the seaweed mixture breaks down toxins, decreases disease susceptibility, and raises the organic content of the soil. (A handful of good soil has more microorganisms in it than people in the world.) One of the best fertilizers is earthworm castings. Earthworms keep the soil well drained, carry organic matter underground, and naturally aerate the soil. The land is aerated by machine once every two years to reduce thatch build up, and to promote water and nutrient exchange. The lawn generally takes four workers three and a half days to mow. The lawn mowers have Japanese liquid cooled engines which burn clean and minimize exhaust. (Thompson)

There are three categories of herbicides: contact, systematic, and soil sterilants. Contact herbicides are applied directly to the plant and prevent photosynthesis. Systematic herbicides induce rapid growth for the plant which soon dies because it cannot obtain enough nutrients for its new size. Soil sterilants abolish the nutrients in the soil that are required for plant growth (Miller 520).

At Sweet Briar, the typical problem of dandelions is controlled by setting the mower blade at three inches, but herbicides are needed for other "weeds." Fast growing onions, unpleasant to look at because they are pale and stick far out of the ground, are controlled by the direct application of a broadleaf herbicide, the “safest” herbicide that could be found to do the job. Surflan is used on pre-emergence weed seeds in shrubs and Round Up, an all purpose, non-selective herbicide, is used on post emergence weeds.

## Dealing with Insects: Pesticides / Biological Controls

There are four basic classifications of insecticides: chlorinated hydrocarbons, organophosphates, carbamates, and pyrethroids. Chlorinated hydrocarbons are the most effective and dangerous insecticides; some are even banned. They have an impact anywhere from two to fifteen years after application and include chemicals such as DDT, chlordane, and toxaphene. Organophosphates generally last one to twelve weeks and include malathion, parathion, and diazinon. Lasting from just days to weeks, carbamates include zineb, temik, and baygon. Pyrethroids last for just days but are natural; heads of Pyrethrum flowers are crushed and used directly or slightly modified chemically (Miller 520).

Surprisingly, organophosphates are more toxic to birds, humans, and animals than chlorinated hydrocarbons and are more likely to contaminate ground water because they are more water soluble (Miller 519). Organophosphates work on insects by inhibiting the enzyme responsible for passing messages through the nerves and to the muscle; this ultimately results in death (Cherfas 30). In humans, organophosphates are known to reduce the liver's ability to detoxify the blood (Girardet and Seymour 134).

There are three main ways to naturally deal with pests. The first is interplanting which consists of planting a variety of plants so that their scents mix and confuse insects and mammals that prey on them. The second consists of maintaining a healthy environment for organisms that can work to ones advantage. Insectivores such as shrews, moles, and hedgehogs eat invertebrates such as woodlice, millipedes, and slugs. Birds enjoy feasting on caterpillars, slugs, snails, and grubs. Slugs and woodlice can also be controlled by frogs and toads. Eelworms, leatherjackets, and insect larvae are controlled by beetles and centipedes. Lady bugs enjoy aphids. Spiders prey on various pests, too. The third natural way involves growing plants, in various areas, that ward off particular bugs and weeds. French marigolds ward off pests that nibble on vegetables; garlic and onions discourage fungus that often bother fruit; insects find the odor of wormwood offending; and herbs such as sage, rosemary, and peppermint fight slugs. Lavendar defends plants from ants and protects roses from aphids (Girardet and Seymour 132).

Pesticides in Sweet Briar's dining hall and kitchen are kept to a minimum. Every two weeks, Dodson Pest Control applies a liquid pesticide around the edges of the kitchen areas, the corners, and the legs of the ovens (pests like warm places). The advantages of liquid application include no gas or spray cloud that travels in the air, direct application to problem areas, and no contact with food. Nothing is ever applied to the serving or dining areas. The only pest that poses a problem is the cockroach which lives in any area near food no matter how clean the building is. Flies are dealt with by using fly swatters, and we do not have any ant or rodent problem. The best strategy for keeping bugs out of the kitchen is to keep it clean (Phelps). Dorms are exterminated every summer.

At Sweet Briar, a mixture of rubbing alcohol and a product named Safer insecticidal soap (consisting of potassium salts and fatty acids) is used for mild pests. This mixture is applied to plants such as those in the dining hall. Orthene is used on bigger pests such as mealy bugs at a frequency of every other week; this is sometimes used on the plants in the dining hall. Bacillus thuringiensis, a dry powder which is non-toxic to mammals, can be used on any caterpillar-type pest and for killer bees and gypsy moths, both for which no natural pesticide exists. For a cotton like disease that forms on Eastern Hemlocks, dormant mineral oil is used (Tyree and Virginia Cooperative Extension Service).

In extreme cases, the organophosphates diazinon and malathion are used for pests such as mealy bugs, aphids, and leafhoppers. Five tiny grains of diazinon can kill a sparrow (Earth Works Group 81). Diazinon is a contact poison that has been known to cause birth defects (Girardet and Seymour). Cygon (dimethoate) is used on our Boxwoods to control leafminer bugs and is also toxic.

Unfortunately, pesticides also can kill natural predators that originally had the target pest under control. Blanket spraying, for the same reason, is dangerous; it kills both the “good” bugs and “bad” bugs (Girardet and Seymour 133). Bug sucking machines have recently been implemented on farms. This abolishes the need for insecticides and lessens the risk of health hazards due to water contamination or direct contact (Sukup). Integrated Pest Management (IPM) has also been shown to be successful. IPM involves considering each crop and its pests separately. Then a combination of biological, chemical, and cultivation techniques are used to minimize the pests and economic loss (Miller 531).

Often pests develop genetic resistance to pesticides. Since insects reproduce rapidly, the immune pests survive and produce the next immune generation. One often ends up with a bigger problem. In the world, approximately 462 insect species, 50 fungi species, 50 weed species, and 10 rodent species have built up resistance to certain pesticides (Miller 522).

When using pesticides, it is important to know the chemicals, their safe use and storage, and their effects. Users need to be certified before implementing pesticides into their plans, whether they are large scale or small scale (EPA). Pesticides upset the natural balance of pest and predators; seeing bugs is a healthy sign! No one wants their rich, beautiful, green land to become a "poison patch."

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# CHAPTER 10
# LAND: SOLID WASTE MANAGEMENT
by Laju Shrestha

## Introduction

"Any useless, unwanted, or discarded material that is not a liquid or gas is classified as "solid waste" (G Tyler Miller 491). Solid waste is anything from rags, junk mail, scraps of food to worn-out appliances and furniture, animal manure, sewage sludge, industrial waste and any other cast-off materials. The total amount of solid waste produced annually in the United States from all sources is estimated to be at least 4.6 billion metric tons (5.1 billion tons), an average of 19 metric tons (21 tons) a year for each American, or 53 kilograms (115 pounds) a day.

The largest category of solid waste (89%) is produced as a result of agricultural and mining activities. Animal manure, crop residues, and other byproducts of agriculture make about half of this figure. The second largest category consists of piles of rock, dirt, sand and slag left behind from the mining and processing of energy resources and nonfuel mineral resources. Industrial solid waste makes up about 8% of the total produced each year. Much of this is scrap metal, plastics, slag, paper, fly ash from electrical power plants and sludge from sewage treatment plants. Urban solid waste produced by homes and businesses in or near urban areas makes up the remaining 3% of solid waste produced in the United States.

Currently, solid waste in the United States has become a major problem. Citizens are faced with diminishing landfill capacities, and disposal fees are increasing. In 1978, there were roughly 14,000 landfills; today there are about 5,500; in 2003, only 1,500 landfills are expected to be in operation. The problem is not due to a lack of space, but rather a lack of public support needed to site new disposal facilities. For this reason, policymakers are looking to reduce the amount of material requiring disposal. (Key Questions and Answers on Paper Recycling 1).

## Throwaway Output Approach

The United States has basically taken three approaches to deal with solid waste: the throwaway output approach, the resource recovery output approach, and the input approach. Today, most states rely on the throwaway output approach. This approach deals with waste by throwing it in the ocean or on the land or burning it in incinerators (G. Tyler Miller 492).

Four output strategies are in general use: dumping, burying, burning and composting. In 1986 Americans spent about $10 billion to have this urban waste collected and disposed of by local sanitation departments or privately owned services. Between 1975 and 1986, average urban waste collection and disposal costs doubled and are continuing to rise as many urban areas run out of convenient places to dispose of their refuse and must haul it farther or find other alternatives.

Currently 82% of the urban solid waste collected in the United States is deposited in sanitary landfills. The remainder is burned in municipal incinerators, recycled, or composted. A sanitary land fill is a waste disposal site that eliminates most of the problems associated with open dumps by spreading waste in thin layers, compacting it, and covering it with a fresh layer of soil each day. The other way to deal with solid waste is to burn combustible materials in municipal incinerators. The ash or residue left from incineration can then be deposited in the landfills or the oceans. Biodegradable solid waste from slaughterhouses, food-processing industries, and kitchens can be mixed with soil and decomposed by aerobic bacteria to produce compost, which can be used as soil conditioner and fertilizer.

## Resource Recovery Output Approach

The resource recovery output approach, on the other hand, is used to turn solid waste into waste that can be reused, recycled, or burned to provide energy (including cogeneration). Usable materials or energy can be recovered from the solid waste using either a centralized high-technology approach or a decentralized low-technology approach. In the ideal high-technology approach, large, centralized resource recovery plants shred and automatically separate mixed urban waste to recover glass, iron, aluminum, and other valuable materials, which are sold to manufacturing industries for recycling. The remaining paper, plastics and other combustible wastes are burned to produce steam, hot water, or electricity, which are then used in municipal facilities or sold to nearby buildings and manufacturing plants. The incinerator residue can be used as landfill to reclaim damaged land or processed into cinder blocks, bricks, or other building materials. By 1986, the United States had 65 resource recovery plants and at least 100 others were under construction or in planning stages.

The low-technology approach, however, is used in the United States to recover most of the solid waste products. The low-technology approach involves separation at the source. Homes and businesses place waste materials such as glass, papers, metals, and food scraps into separate containers. Compartmentalized city collection trucks, private haulers, or volunteer recycling organizations pick up the segregated wastes, clean them up if necessary, and sell them to scrap dealers, compost plants, and manufacturers. By 1986, more than 250 U.S. cities had curbside pickup of separated wastes. More then 3,000 municipal or community-based recycling centers together recycle 12 million tons of trash for an annual cash return exceeding $380 million.

The low-technology approach produces little air and water pollution, has low start-up costs, moderate operating costs, and saves more energy and jobs for unskilled workers than high-technology resource recovery plants. While it costs an average of $30 a ton to recycle solid waste, it costs $50 a ton to place such waste in a landfill, and $65 to $75 a ton to incinerate it. Mixing of wastes and sending them off to landfills or resource recovery plants also hinders the recycling of paper and encourages the use of throw away cans and bottles (G. Tyler Miller 498).

## Input Approach

Input approaches are the least used, but the most promising means of waste management. The input approach is designed to produce less solid waste. Input approaches include reducing average per capita consumption by buying things one really needs rather than merely wants, increasing the average lifetime of products, decreasing the amount of material used in some products, using less packaging, and designing products for easier repair, reuse, and recycling.

## Virginia's Waste Management Policy

The State of Virginia has taken a number of measures to manage its solid waste. It passed laws and regulations in compliance with the national laws and regulations as well through its own initiatives. The Code of Virginia was passed in 1950 to "promulgate and enforce such regulations as may be necessary to carry out its duties and powers and the intent of the Virginia Waste Management Act and the federal acts" (Solid Waste Management Regulations 17). The purpose of these regulations is to establish standards and procedures pertaining to the construction, operation, maintenance, closure and post-closure of solid waste management facilities in the commonwealth in order to protect the public safety, the environment, and natural resources.

The Solid Waste Management Regulations in Article 2 require permits and prohibit open dumps. It states that "no person shall operate any sanitary landfill or other facility for the disposal of solid waste without a permit from the Director." It also says that, "the sanitary landfill or other facility used for disposal of solid waste is maintained or operated in such a manner as to pose no substantial present or potential hazard to human health or the environment" (Solid Waste Management 105). In addition to this, it takes care of permits amendments, financial responsibility for abandoned facilities and designation of regional boundaries, regional solid waste management plans, contracts by counties, cities and towns and gives state aid to localities for solid waste disposal.

Article 2.1 deals with the litter control and recycling program. The purpose of this article is to accomplish litter control throughout the Commonwealth by delegating to and vesting in the Department of Waste Management, authority to conduct a continuous program to control, prevent and eliminate litter from the Commonwealth and to encourage the recycling of discarded materials to the maximum practical extent (Virginia Waste Management Act 107).

By December 31, 1991 the Virginia Waste Management Board wants to achieve a recycling rate of 10% of the total of household wastes and principal recyclable materials that are wastes from non-household sources generated annually in each city, county, town or region. By December 31, 1993 it wants the recycling rate to go up to 15% and by December 31, 1995, to 25% of total household wastes. (Regulations for the development of solid waste management plans 6, Mr. Jacques.)

## Solid Waste Management at Sweet Briar

Sweet Briar College is very much involved in managing its own solid waste products. The College handles its garbage pick-ups through the Housekeeping Department. Prothro Commons (college cafeteria) does an excellent job in preventing and using most of its solid waste products. SWEEP is a well praised college club that promotes recycling of solid waste in and outside of the college. (See Photo. 10-1.)

Almost all of the solid waste produced on campus is handled by the Housekeeping Department. Garbage is picked up six days a week. The department also picks up the separated aluminum cans, bottles and high grade paper for SWEEP. The garbage is taken to the landfill three times a week in a 10 cubic yard truck.

The Resource Management class had the opportunity to visit the Amherst Landfill. Mr. Dan French, the manager showed us around and gave us some facts about the landfill. The landfill was purchased in 1972. In 1978-1980, it started taking garbage from Lynchburg. In 1980, it also took in trash from Madison Heights. In 1991-1992, the landfill is going to move to Madison Heights because the Amherst landfill is filling up and because of the new, stricter regulations. The new landfill will be situated at a greater distance from airports, streams, off-site wells, public roads, residences, high ground water bedrock, and property than required by State regulations. These new regulations also specify surface water protection, ground water protection and air quality protection.

Plastic bags, plastic bottles, and tires pose major problems for the landfills. Plastic bags are blown by the wind across the landfill and the surrounding acres, before they

Photo. 10-1. SWEEP Recycling Trailer. The trailer accepts glass, aluminum, newsprint, high-grade paper, cardboard, magazines, and non-clear plastics.

can be compacted. When people throw away plastic bottles they usually put the lids on the bottles. This creates an air tight container that cannot be compacted. After time, the bottles resurface. The problem with tires is that they, too, resurface because they retain air in their inner rim. The easiest solution is to refrain from putting lids on soda bottles. Another alternative is to take these materials to a recycling center.

Even prior to SWEEP, says Bruce Thompson, the Superintendent of Housekeeping, the employees recycled aluminum cans, newspapers, and computer papers in their spare time. One employee even collected enough cans to buy a car!

The amount of garbage picked up on campus is increasing all the time. However, the difference between the amount of garbage picked up in the past and the present is that there are more and more recyclable wastes. Mr. Thompson predicts that the buildings on campus are going to have several more trash cans to sort out the recyclable waste products as people become more and more conscious of the environment.

## Cafeteria Waste

The food waste in the cafeteria is very well managed. It tries to avoid or lessen the amount of food wasted by keeping a production usage chart. The chart shows the number of people that come to the cafeteria on a daily basis for all the menus. This way the staff can plan ahead and see what type of food to produce and for how many people.

The waste in the cafeteria is divided into three categories. There is the food waste, storage container waste and the basic garbage. The cafeteria tries to reuse some of the left over food in another menu, if it is still fit for human consumption. However, if it is not then they throw it away or give it to their employees. Approximately 65% of the food that is left over is taken by the employees to feed their hogs. The employees also take about 20% of the inedible food for the same reason. The rest of the food waste goes to the sewer through the garbage disposal grinder. Food products, like cow feces, raise the biological oxygen demand, which is reduced at the sewage treatment plant. (See Chapter 5.)

The container waste and the basic waste are collected and disposed of by the Housekeeping Department. The garbage is picked up by the trash truck twice a day; once in the morning and once in the evening. Approximately three men take half an hour to pick up one load of garbage from the cafeteria.

The cafeteria also manages its used-oil or grease. The cafeteria does not send it to the landfill. Instead, it saves the grease for the grease collecting company. The company gives the cafeteria a nominal fee of $3 for 55 gallons of grease collected. This is particularly important because grease is a major problem at the sewage treatment plant. (See Chapter 5.)

The cafeteria has not resorted to composting at the present because it is not economically feasible. Composting involves a lot of labor for separation of food stuff which is mixed up with plastics and paper, storage costs, transportation costs as well as initial costs to buy the composting equipment. Thus, the cafeteria would require not only more money, but also more labor for composting. The cafeteria would also have to follow more health regulations. The cafeteria would definitely look into composting for the future if it got the kind of support it needed. The cafeteria would require an overhead commitment from the college as well as the county. It would require looking into the time and cost management.

Mr. Archie Waldron, the Director of Food Services observes that students could also contribute to waste management in the cafeteria by reducing the amount of food they throw away. He suggests that students clear their own trays in the trash can and weigh the trash can at the end of the day. This will promote an awareness of how much food students waste. He said, however, that the initiative must come from the students themselves. Mr. Waldron is directly involved in implementing the elimination of styrofoam products as well as the introduction of paper products in the Bistro (college cafe) . For this he received the Lorax Award from the Environmental Studies Department for service to the environment above and beyond the call of duty.

## SWEEP

SWEEP is the best example of students and faculty on campus dedicated to environmental concerns. SWEEP stands for Sweet Briar Environmental Project (Appendix F-1). SWEEP has been in operation since the Fall of 1988. The goal of SWEEP is not only to reduce the amount of trash the campus produces, but to recycle what can be recycled. SWEEP is also very much interested in educating the community and helping them get into the habit of recycling (SWEEP Notebook; Appendix F-2).

Initially a number of students and staff wives went to the Business Affairs office and talked to Mr. Tom Connors, the Vice-President and Treasurer of the College, about the possible ways of starting a litter control and recycling program. They then decided to form a group. They brainstormed on what the group could be called and how they should go about starting this project (SWEEP Notebook).

SWEEP's original plan was to collect aluminum, glass and paper in all buildings and have it removed by the Sweet Briar Housekeeping Staff with some help from volunteers.

However, such a plan proved too ambitious and costly. Therefore, they decided to stick to a much smaller scale. They targeted specific areas, e.g. dormitories, library and the computer center to set up the various trash bins for different items. They had the trash bins labeled and signs put on the bulletin boards to remind people of what things went to which bins (Appendix F-3). The separated waste is picked up by the Housekeeping staff and deposited in the SWEEP trailer in Elijah Road (near the elementary school). This trailer is provided by Bryant Salvage Company for the College. The company also happens to be the recycler who purchases the waste products that SWEEP collects. SWEEP has chosen this particular recycler because it is located in the same county as the College.

SWEEP is saving the college $30 per trip to the landfill. Just in its life span of 1 1/2 years it has made approximately $500 from recyclable materials (Appendix F-4). The money that is generated is given back to the college for financing the extra housekeeping help and helping out with various needs of SWEEP.

SWEEP is also involved in "adopt a highway" program. SWEEP has officially adopted two miles of Highway 29. SWEEP brings not only recycling awareness on campus but also outside the campus. SWEEP has presented workshops to southwestern Virginia Colleges and universities and encouraged schools to start their own recycling program. SWEEP has been working with the Amherst Country Litter Control. It has been recognized by Virginia for its outstanding work. On October 1988, SWEEP received the Virginia Beautiful award. SWEEP has also been commended for its part in the "Take Pride in America" campaign.

## The Future

For the future, SWEEP definitely wants to recycle more waste products. It wants to encourage students who take environmental classes to do cost/benefit analyses on the purchasing of products (such as paper) made from recycled materials (Appendix D). It wants to examine the use of the Sweet Briar dairy farm on the use chemical fertilizers and to investigate the possibilities of a compost site on campus. It wants to determine hazardous chemical use on campus. It is also determined to take a more active role in politics. It wants to raise more consciousness within and outside of campus.

Solid waste management has come to play a very significant role in today's society due to diminishing landfills. People nationwide are forced to take measures to reduce, recycle or burn waste. The United States has traditionally taken the throwaway output approach, but is slowly moving toward the resource recovery output approach and the input approach to deal with solid wastes. Virginia has passed laws and regulations to encourage this change. Sweet Briar College is a leader in these changes.

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# APPENDICES

## Appendix A-1. Pilot Study: Electricity Use in Manson's TV Room

by Jennifer Jarvis

"Most of the (energy) uses in the residential and commercial classifications have the common characteristics of contributing personal comfort: lighting and heating and cooling in homes, schools, theaters, offices, and stores; and the operation of dozens of other appliances from kitchen stoves to office equipment" (Landsberg 14). This statement applies equally well to the energy use here at Sweet Briar College. According to Mr. Wheeler, superintendent of Sweet Briar's Physical Plant, the main consumer of electrical energy on the campus is lights followed distantly by electric motors. Although not near as much as lights or electric motors, appliances such as television sets also use a good amount of electricity on the campus.

According to K. W. Riegel in his talk about energy conservation at the national forum in December, 1975, "Lighting in the United States accounts for about five to six percent of the total primary national energy consumption. Between twenty and twenty-five percent of all electricity goes for lighting uses, including both direct energy consumption and indirect energy demands for cooling requirements" (444). In 1973, it was found that lights consumed 1.09 mQ of total energy in the residential sector. (Distribution of lighting by end-use is in Table 2.) A milliQuad (mQ) is equal to 1 x 10 BTUs (British Thermal Unit). A BTU is the measurement of energy required to raise one pound of water one degree Fahrenheit. Since energy is usually referred to as watt-second or joule, the BTU is roughly equal to 1000 joules. If 63.5 hours per week is used for lighting in just one week of the school year in just one of the seven dorms, think how much energy in just the housing sector of Sweet Briar College is used in a school year.

A black and white television set similar to the one in the Manson dorm requires an average power of 55 watts. If the television in Manson is used an average 7 hours per day, that is 385 watts per day. According to Riegel's tables, televisions used the equivalent of 230 thousand barrels of oil per day in 1972. In 1974, televisions used the equivalent of 236 thousand barrels of oil per day (449). Surprisingly enough, television sets are quite frequently watched here at Sweet Briar College. In my survey (Table 1), I found the television set in the Manson T.V. room to always be on during the allocated Soap Opera time. The television set was also on every day during prime time at night (which is from 8:00PM to 10:00PM).

As an average, the physical plant reports Sweet Briar College as using 40,000 watts of energy per twenty-four hours. The plant has found that the peak load during this twenty-four hours occurs at nine PM. More energy is used on campus during the months of November and February than any other months. The same is true for the amount of water used on campus. Sweet Briar's electricity is bought from Appalachian Power Company while the campus' steam and water treatment is done at the physical plant on campus. The campus uses steam to heat the buildings and to provide hot water to the bathrooms and the dining hall kitchen. The campus heats an average of 280,000 pounds of steam per day. The plant uses coal and fuel oil to produce the steam. The school also goes through 140,000 gallons of water per day.

There are a few ways that Sweet Briar College could cut down the amount of energy it uses for lighting. The most efficient method would be to replace all the bulbs on campus with energy efficient bulbs such as fluorescent bulbs. Another method, although less efficient, would be to place signs around the campus at light switches reminding people to save energy and turn off the lights. Other than the purchase of energy-efficient sets, there are not many ways Sweet Briar could cut down the amount of energy used for television sets.

## DATA COLLECTION

### LIGHTS IN MANSON T.V. ROOM

Total: 74.0 hours/8 days
Average: 9.2 hours/day
Total amount of use in AM hours: 18.5 hours for the eight days surveyed
Average for AM hours: 2.3 hours per AM hours of a day
Total amount of use in P.M. hours: 56.5 hours for the eight days surveyed
Average for P.M. hours: 7.6 hours per PM hours of a day
Peak days for survey period: Tuesday November 28, 1989 and Monday December 4, 1989

### TELEVISION IN MANSON T.V. ROOM

Total: 55.5 hours/8 days
Average: 6.9 hours/day
Total amount of use in AM hours: 7.5 hours for the eight days surveyed
Average for AM hours: 0.9 hours per AM hours of a day
Total amount of use in PM hours: 48.0 hours for the eight days surveyed
Average for PM hours: 6 hours per PM hours of a day
Peak day for survey period: Monday December 4, 1989

## PERCENTAGE OF TOTAL LIGHTING ENERGY ALLOCATED ACCORDING TO END USE

(Found on Page 451 of Energy Conservation: A National Forum)

| | |
|---|---|
| Residential | 20% |
| Store | 19 |
| Industrial | 19 |
| Offices | 10 |
| Outdoor advertisement, area lighting, sport lighting | 8 |
| Schools | 7 |
| Streets and Highways | 3 |
| All other indoor (public bldgs., garages, hospitals, etc.) | 14 |
| | 100% |

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## Appendix A-2. Pilot Study Data: Incidences of Light Use in House 1

by Angela Hickman

Over a 4 week period (March 11 to April 14, 1990), House 1 was monitored for instances of lights being left on when noone was in the rooms. There were a total of 110 instances reported by members of the house.

| Time Periods | Instances |
|---|---|
| 12 AM - 6AM | 5 |
| 6AM - 12 PM | 14 |
| 12 PM - 6 PM | 53 |
| 6 PM - 12 AM | 38 |

| Days | Instances |
|---|---|
| Monday | 19 |
| Tuesday | 23 |
| Wednesday | 19 |
| Thursday | 10 |
| Friday | 12 |
| Saturday | 11 |
| Sunday | 16 |

| Rooms | Instances |
|---|---|
| Downstairs Kitchen | 14 |
| Upstairs Kitchen | 4 |
| Downstairs Bathroom | 3 |
| Upstairs Bathrooms | 18, 32 |
| T.V. Room | 38 |

## Appendix B-1. Smoking Survey

1. Whether you smoke or not, are there times that smoke bothers you? Yes No

2. Where does it bother you the most? Dining hall room academic buildings during tests/exams bathrooms halls Bistro TV rooms/lounges professors' offices other____________

3. How do you feel about smoking bans in public places?

4. Do you think SBC need stricter smoking regulations and, if so, where?

5. In your opinion, what percentage of SBC students smoke?

6. If you don't smoke now, did you ever? Yes No
For how long? _____ Why did you quit? __________________

7. Do you smoke? Yes No

8. How long have you smoked? _____________

9. Where do you smoke the most? room dining hall parties other_______

10. Did you smoke when you came to SBC? Yes No

11. If not, when did you start smoking at SBC? Fresh Soph Jr Sr

12. Why did you start smoking? peer pressure everyone else does
it's cool pressure/stress

## Air Filter Use Survey

1. Have you ever had any previous experiences with the use of air filters? If so, did you find them helpful in treating air quality? - include conditions under which the filter(s) was(were) used. (ie. smoking)

2. Would you or have you ever considered buying an air filter for your own personal use? Yes No

3. Do you think that you would respond differently if presented with more information on the quality of indoor air and related health problems, especially those related to smoking or certain chemicals? Yes No

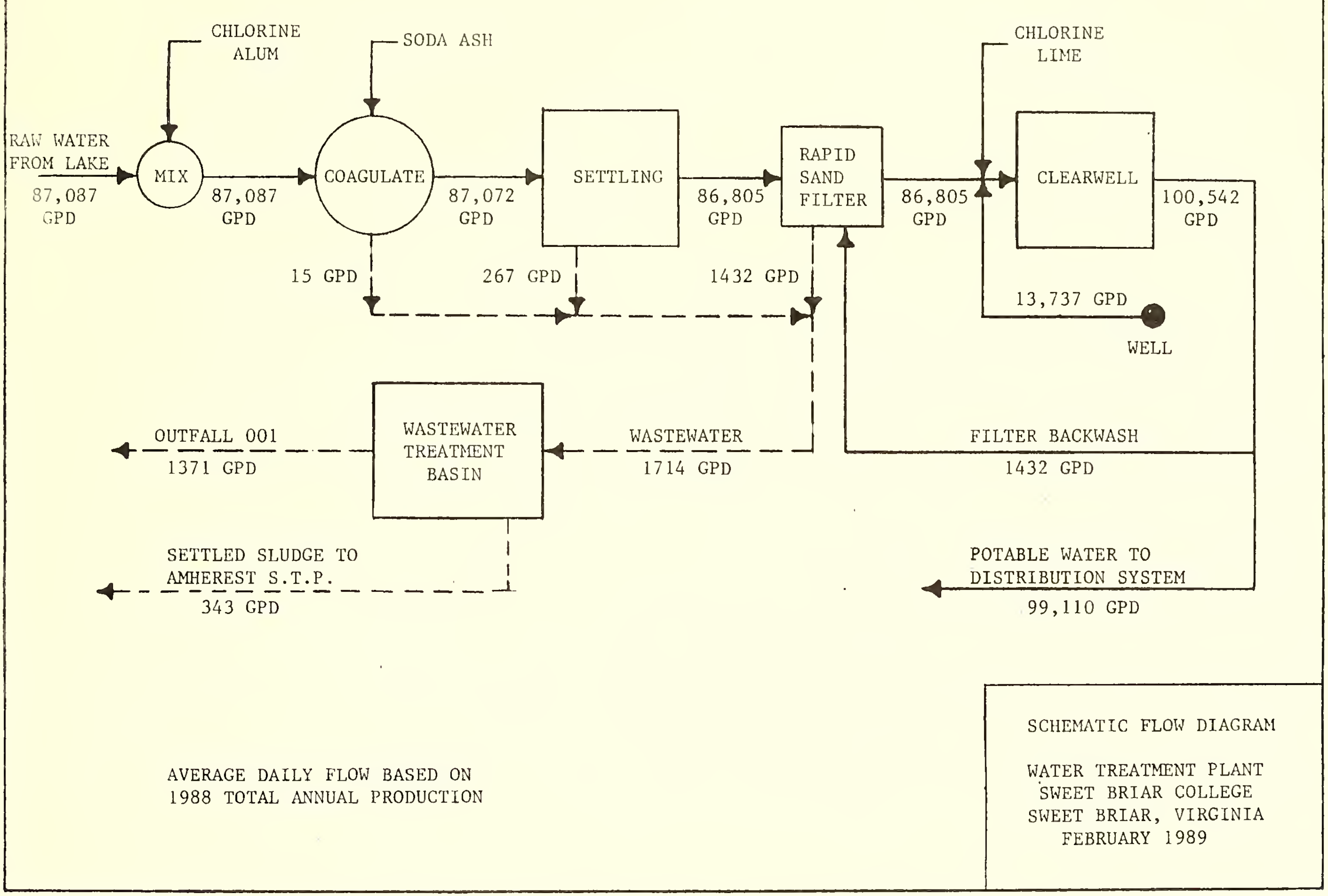
## Appendix B-2. Air Filter Use Results

1. Have you ever had any experience with the use of air filters?
Yes - 19% No - 81%
If so, did you find them helpful in treating air quality?
Yes - 50%

2. Would you or have you ever considered buying an air filter for your own personal use?
Yes - 51% No - 49%

3. Do you think that you would respond differently if presented with more information on the quality of indoor air and related health problems, especially those related to smoking or certain chemicals?
Yes - 84% No - 16%

Appendix C-1. SBC Water Treatment Plant Schematic Flow Diagram



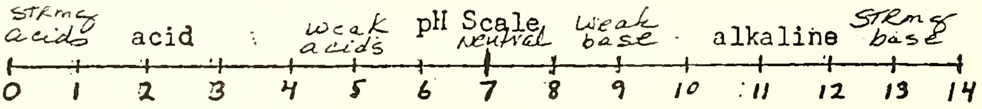
## Appendix C-2. Selected Analyses Commonly Run on Public Water Supplies

### pH

Among the many elements and compounds that a natural water may contain, the acids and alkalies are very important. These compounds break up or dissociate in water and the acids release hydrogen ions (H) and the alkalies release hydroxal ions (OH). Both of these, hydrogen ions (H) and hydroxal ions (OH) are always present. If there are more hydrogen ions then the water is said to be acidic. On the other hand if hydroxal ions are the most numerous, then the water is said to be alkaline. The number of hydroxal ions is directly related to the number of hydrogen ions. Thus we only need to know the amount of one of these in order to know the amount of the other.

The number of hydrogen ions or hydroxal ions in water is given by the pH of the water. If the pH is above 7, the water is alkaline, if below 7, the water is acid, and if it is right on 7, it is considered a neutral water. An acid water may have a pH as low as 0 and alkali water a pH as high as 14.

The effectiveness and economics of such processes as chlorination, coagulation and corrosion control are influenced by pH. The pH test is often required to determine the proper chemical dosage for a treatment. Many water treatment plants in southern Virginia have found that they achieve their best chemical coagulation when the "mixed water" of the flocculators is maintained at a pH of 6.5-7.0.



pH VALUES OF SOME SOLUTIONS

| Solution | pH Value |
|---|---|
| 5% Sulfuric Acid | 0.0 |
| Acid Mine water | 2.0 |
| Vinegar-HCl | 3.0 |
| Fresh waters | 8.0 |
| Milk | 6.0 |
| Neutral waters | 7.0 |
| Sea water | 8.0 |
| Milk of Magnesia | 10.0 |
| Saturated lime | 12.4 |
| 4% Sodium Hydroxide | 14.0 |

## ALKALINITY

The alkalinity of a water is a measure of its capacity to neutralize acids. The alkalinity of natural waters is due primarily to the salts of weak acids, although weak or strong bases may also contribute. Bicarbonates represent the major form of alkalinity, since they are formed in considerable amounts from the action of carbon dioxide upon basic materials in the soil. Other salts of weak acids, such as borates, silicates, and phosphates, may be present in small amounts. A few organic acids that are quite resistant to biological oxidation - for example, humic acid - form salts that add to the alkalinity of natural waters. Although many materials may contribute to the alkalinity of a water, the major portion of the alkalinity in natural waters is caused by three major classes of materials which may be ranked in order of their association with high pH values as follows: (1) hydroxide, (2) carbonates, and (3) bicarbonates. For most practical purposes, alkalinity due to other materials in natural waters is insignificant and may be ignored. All forms of alkalinity are expressed in terms of calcium carbonate ($CaCO_3$).

The alkalinity of waters is due principally to salts of weak acids and strong bases, and such substances act as buffers to resist a drop in pH resulting from acid addition. Alkalinity is thus a measure of the buffer capacity.

+ Typically we measure alkalinity as phenolphalein alkalinity (pHth) by titrating a sample to pH 8.3 with 0.02 N $H_2SO_4$. The results give us the total of all hydroxide and one-half of the carbonate alkalinity. When the titration is continued to pH 4.5 the resulting total alkalinity includes all hydroxide, carbonate and bicarbonate alkalinity.

Chemicals used for coagulation of water and wastewater react with water to form insoluble hydroxide precipitates. The hydrogen ions released react with the alkalinity of the water. Thus the alkalinity acts to buffer the water in a pH range where the coagulant can be effective. Alkalinity must be present in excess of that destroyed by the acid released by the coagulant for effective and complete coagulation to occur. Alkalinity of most surface waters in Southern Virginia exist in the bicarbonate form. Although, carbonate alkalinity frequently increases when algal activity is at its peak in the summer. Higher carbonate and even hydroxide alkalinity are found in the limestone sections of the state, such as the Shenandoah Valley.

## Carbon Dioxide ($CO_2$)

Largest problem is $CO_2$

Carbon dioxide is present in all surface waters in amounts generally less than 10 mg/l, though higher concentrations in ground waters are not uncommon. ✗Appreciable concentrations may be produced under acid conditions by the destruction of bicarbonate compounds. ✗The bacterial decomposition of organic compounds also increases the $CO_2$ level. Sudden increases in raw water algal activity (blooms) result in an abrupt drop in $CO_2$ as the algae use it as a raw material in the process of photosynthesis. High carbon dioxide concentrations produce no health hazard but are corrosive. While the addition of alum or ferric chloride may raise $CO_2$ levels slightly alkalies such as lime, soda ash and caustic soda reduce its levels. Aeration, or filtration tend to strip out carbon dioxide so that most finished waters contain very minimal concentractions.

## TURBIDITY

One of the easiest measures of water quality for the average consumer to evaluate is the turbidity or cloudiness of the water. The reduction in the intensity of a beam of light as it passes through a turbid water is a measure of the turbidity of the water. This turbidity results from the suspended material in the water which may be fine insoluble materials such as clay, silt, or sand or organic materials from natural run-off or manmade waste. Any raw water with a turbidity above 5 units should be treated to bring the value below this level. Knowledge of the turbidity variation in raw-water supplies is of prime importance to the water plant operator. He uses it in conjunction with other information to determine whether a supply requires special treatment by chemical coagulation and filtration before it may be used for a public water supply. Turbidity measurements help to guage the amount of chemicals needed from day to day in the operation of treatment works. This is particularly important on "flashy" rivers where no impoundment is provided. Measurement of turbidity in settled water prior to filtration is useful in controlling chemical dosages so as to prevent excessive loading of rapid sand filters. Turbidity measurements of the filtered water are needed to check on faulty filter operation. A well operated surface water treatment plant should produce a finished water well below 1 unit.

*Note: Do not confuse turbidity with color, which results from dissolved organics rather than suspended materials.

## IRON

Iron (Fe) is one of the most abundant elements on the earth's surface. As water runs over the earth's surface and percolates down through the soil, iron is dissolved from the soil and rocks. Ground water generally contains more iron than surface water. The more acid a water contains, the easier it dissolves the iron. Iron can occur in several forms in water. In the ferrous (Fe+2) form it is dissolved and is not visible. If air is added to the water, the oxygen in the air oxidizes the iron to the ferric (Fe+3) form. This oxidized form of iron is reddish-brown and is a form of rust.

A limit is not put on iron in water from the public health standpoint, but rather from the aesthie standpoint. Concentrations as low as 0.3 mg/l can cause reddish-brown stains on porcelain or on clothes washed in this water. Small amounts of iron may cause off tastes in foods or beverages.

## MANGANESE

Manganese (Mn) is similar to iron in its occurrence and in the problem it causes. It is not as abundant as iron in nature. Problems with manganese (Mn) often arise in lake or reservoir waters since it may be dissolved from the bottom muds. Reservoir concentrations frequently fluctuate between <0.2 mg/l in winter to >2.0 mg/l during periods of reservoir turnover. Manganese causes problems with blackish staining. The concentration should be maintained below 0.05 mg/l to eliminate staining problems. Often a treatment process is designed to remove both iron and manganese.

# HARDNESS

Hard waters are generally considered to be those waters that require considerable amounts of soap to produce a foam or lather and that also produce scale in hot-water pipes, heaters, boilers, and other units in which the temperature of water is increased. With the advent of synthetic detergents, many of the disadvantages of hard waters for household use have been diminished. However, soap is preferred for some types of laundering and for personal hygiene, and hard waters remain as objectionable as ever for these purposes. The scaling problem continues to be a consideration. The hardness of waters varies considerably from place to place. In general, surface waters are softer than ground-waters. The hardness of water reflects the nature of the geological formations with which it has been in contact and is usually caused by calcium and magnesium. The softest waters are found in the New England, South Atlantic, and Pacific Northwest states, Iowa, Illinois, Arizona, New Mexico, and the Great Plains states have the hardest waters.

Waters are commonly classified in terms of the degree of hardness, as follows:

| mg 1 | Degree of Hardness |
|---|---|
| 0-75 | Soft |
| 75-150 | Moderately hard |
| 150-300 | Hard |
| 300 up | Very hard |

As with alkalinity, hardness is expressed in terms of $CaCO_3$

## Types of Hardness

In addition to total hardness, it is desirable and sometimes necessary to know the types of hardness present. Hardness is classified in two ways. (1) with respect to the metallic ion and (2) with respect to the anions associated with the metallic ions.

## Calcium and Magnesium Hardness

Calcium and magnesium cause by far the greatest portion of the hardness occurring in natural waters. In some considerations it is important to know the amounts of calcium and magnesium hardness in water. For example, it is necessary to know the magnesium hardness or the amount of $Mg^{2+}$ in order to calculate lime requirements in lime-soda ash softening. The calcium and magnesium hardness may be calculated from the complete chemical analysis. Such information is not always available, and recourse is made to some method of analysis that allows separate measurement of calcium or magnesium hardness. If calcium hardness is determined, magnesium hardness is obtained by subtracting calcium hardness from total hardness, as follows:

Total hardness - Calcium hardness = Magnesium hardness

This procedure yields reasonably reliable results because most of the hardness in natural waters is due to these two cations. Most methods for measuring calcium hardness will also include strontium hardness.

TO: DIVISION OF WATER SUPPLY ENGINEERING
Virginia Department of Health

Place Sweet Briar College WTP

County Amherst

## Appendix C-3. Memorandum: Report of SBC Water Supply

System Owned By Sweet Briar College

Inspection By T. N. Hamner TNH Time Spent 6 hrs. w/travel

Date of Inspection 21 November 1989 Date Memo Written 22 November 1989

Present at Inspection Gordon Wheeler, Superintendent of Water and Wastewater,
(Official, Operator, or Interested Person)

Lucy Mason-Viers, Operator

Structure(s) Inspected Water Treatment Plant, well and storage tanks

Pop. Served 800 No. Conns. 22 + school Avg. Daily Usage 0.099 MGD*

PWSID No. 5009350

Plant Capacity 0.207 MGD Well Capacity 0.014 MGD

Monthly Production WTP 3.345 MG*
Well .600950 MG*

*October 1989

Total Population Served 800+

Primary 800+ Consecutive N/A

Consecutive

Source Sweet Briar Lake Drainage Area (Mi$^2$) 0.81

Auxiliary Source(s) Upper and lower lakes within same drainage area

Drainage Area (Mi$^2$) 1. 2. 3.

Raw Water Pump & Capacities: 1. 2 centrifugal pumps rated 150 gpm @ 40 TDH

2.

3.

Raw Water Impoundment Volume & Surface Area:

1. Upper lake 2,000,000 gals. 4 acres

2. Lower lake 31,000,000 gals. 9 acres

3. gals. acres

-over-

REMARKS:

The purpose of this inspection was to perform a sanitary survey of the subject waterworks and inspect the modifications to the chemical feed system. The water treatment plant consists of raw water pumping, chemical addition, a suspended solids contact unit, a Graver unit, sedimentation, filtration, disinfection and finished water pumping. A well is also provided which discharges to the clear well. A 500,000 gallon and a 75000 gallon atmospheric-type storage tank is provided for this system.

According to the operator, raw water is being pumped from the upper lake because the turbidity of the lower lake is considerably higher.

Alum and chlorine were added to the raw water in the contact unit, and soda ash was being added to the Graver unit. Chlorine and lime were being added to the finished water.

The chemical dosages are provided below:

| Chemical | Raw Water | Finished Water |
|---|---|---|
| Soda Ash | 10.4 ppm | -- |
| Alum | 5.2 ppm | -- |
| Chlorine | 2 ppd | 1 ppd |
| Lime |  | 1 gpg |

New metering pumps (Chem Tech Series 100-030) have been set up for alum and soda ash. The old dry feeders are still connected to the system. The new pumps are connected to the system by a tee in the solution line from the old feeders. The solution line from the metering pumps is set into the open section of the tee. The operator calibrates the pump using this open connection. An air gap needs to be provided between the discharge line from each respective pump and the solution header. The feeders are presently on a 30% (of capacity) setting for alum and a 60% setting for soda ash. The pumps are manually operated. At the end of each day the operator flushes each pump.

The solutions are mixed in a spare 50-gallon tank and then placed into service. When the metering pumps are connected permanently, a water line will be extended from the finished water to the 50-gallon solution tanks. An appropriate air gap will be needed from this line to each solution tank for proper protection.

A metering pump was used for lime on a trial basis. The agitator being used was not large enough to keep the lime in solution, so this was discontinued until the dry feeder can be removed and properly sized equipment can be installed.

A match head sized floc was forming in the Graver Unit. There was some carryover to the sedimentation basin. The floc settled very well in the sedimentation basin and no carryover was noted to the filter.

-continued-

The sand filter appeared to be in good condition. A filter drop test was performed and the filtration rate was determined to be 1.96 gpm/ft$^2$.

The clear well was examined during the inspection. The roof and screens were in good condition, and the water was clear.

Well - The well is located in the same building which houses the finished water pumps and an emergency generator. The floor is a concrete slab and the well casing is approximately 4-inches above the floor. The well casing is provided with a sanitary seal, screened vent and drawdown gauge. The well discharge line is equipped with a pressure gauge (which indicated 15 psig), a gate valve, a water meter (the totalizer indicated 6052120 gallons and water was being pumped at 12 gpm), a check valve and a threadless sample tap. The piping was wrapped in insulation and a heat lamp was provided. The oil storage tank for the operation was within 10' of the well.

The day's laboratory results were noted during the inspection and are provided below:

| Test | Raw Water | Applied Water | Finished Water |
|---|---|---|---|
| pH | 6.0 | 6.8 | 7.7 |
| Turbidity (NTU) | 3.2 | 1.8 | 0.9 |
| Alkalinity (mg/L as $CaCO_3$) | 29 | 29 | 49 |
| $CO_2$ (mg/L) | 1 | ---- | 0 |
| Chlorine Residual (mg/L) | ----- | 1.0 | 1.0 |

Storage - A 500,000 gallon and a 75,000 gallon storage tank are provided for this system. Both tanks are equipped with ladders (with a locked cover), screened vents, and access hatches.

Annual compliance samples for metals, inorganics, pesticides and radioactivity were collected on 23 February 1989. The results indicated that the water met all State and Federal standards for drinking water for those constituents tested. The bacteriological quality of the water has been satisfactory for the last year.

The lead notification has been completed. A cross-connection control program has not been approved by this office.

Recommendations:

1. A cross connection control program for this water system must be submitted to this office for review and approval. This was discussed with Mr. Kestner in a telephone conversation on 22 November 1989. An example program will be provided for use and guidance. A program needs to be submitted within approximately 60 days for approval.

-over-

2. The well casing needs to be extended 12-inches above the floor.

3. The fuel oil storage tank for the emergency generator needs to be moved at least 50 feet from the well.

4. The new chemical feed equipment is being evaluated separately and comments will be forwarded on this matter.

TNH:kcw

cc: A. R. Hammer, VDH-Central
Amherst County Health Department
Frank H. Fedorovich, Sweet Briar College
Lucy Mason-Viers, Operator

Answers to comments

1. This matter is being completed by another department.

2. This was completed 1/16/90.

3. This was completed 1/16/90.

4. Comments are enclosed on a separate sheet.

PLANT SWIFT BR AP

DATE 21 NOV 39

INSPECTOR JN HAMNER

# FILTER DROP TEST RESULTS

NO. OF FILTERS -

FILTER AREA -

GULLET AREA -

TOTAL AREA - 72 ft²

VOLUME FILTERED 37.5 ft³

| FILTER No. | TIME FOR 6" DROP | CALC. FILTRATION RATE | RATE OF FLOW INDICATOR/RECORDER | HEAD LOSS INDICATOR | HEAD LOSS MEASUR |
|---|---|---|---|---|---|
| 1 | 1:59 | 1.96 gpm/ft² |  | 3.75' |  |
|  |  |  |  |  |  |
|  |  |  |  |  |  |
|  |  |  |  |  |  |

3 2 DCLS REC'D [illegible]

LAB #: 90963 FEB 27 89
1-6

NAME OF WATER SYSTEM: SWEET BRIAR COLLEGE
SOURCE: SURFACE WATER

REPORT RESULTS TO HEALTH OFFICIAL AT:
Office of Water Programs
Danville Regional Office
1347 Piney Forest Road
Danville, Virginia 24540

Water Quality Report

**INORGANIC**

WSE-50

Commonwealth of Virginia
Department of Health
Division of Water Programs
Bureau of Water Supply Engineering

RECEIVED 1989 Off. of Water Programs DANVILLE REGIONAL OFFICE

# Appendix C-4. SBC Water Quality Report: Va. Dept. of Health

REGION: ☐ Abingdon ☐ Culpeper ☒ Danville ☐ Lexington ☐ Richmond ☐ Virginia Beach ☐ Local Health Dept ☐

PLANNING DISTRICT # 11

SAMPLING LOCATION: Phy. Power Plant Office

COUNTY: AMHERST

CODE: ☐☐☐ 7-9 Sweet Briar College

INDEPENDENT CITY:

SOURCE TYPE: ☒ Public-Community ☐ Public-Noncommunity

FIELD TESTS: Temp: Cl2: mg/L CO2 mg/L
pH: Alk: mg/L Hard.: mg/L

P.W.S.I.D. #: 5 0 0 9 3 5 0 (10-16)

TRANSACTION CODE 0 3 (17-18)

DATE COLLECTED
Mo 02 Day 23 Yr 89
19-24

TIME: 1 6 0 0

COLLECTED BY: L-MASON-VIERS

CONTAINER TYPE:
☐ Glass
☒ Plastic

PRESERVATIVE USED:
☒ None
☐ Ice
☐ Other
☐ Nitric Acid

SAMPLE TYPE:
D ☒ Reg. Dist.
P ☐ Plant Tap
R ☐ Raw Water
C ☐ Check
M ☐ MCL Check
S ☐ Other
29

| CONT. I.D. | | | | CONTAMINANT NAME (Maximum Allowable Level) | MTD. | | | S | ANALYSIS RESULTS | | | | | | | | PRECISION | | | | ANALYSIS DATE Mo | Day | Yr | A* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 9 | 2 | 5 | pH (6.5 8.5) | 1 | 3 | 5 | | 0 | 0 | | 7 | 7 | 5 | 0 | 0 | ± | | | | 02 | 2[illegible] | [illegible] | JBT |
| 1 | 9 | 2 | 7 | Alkalinity-Total | 1 | 5 | 7 | | 0 | | 3 | 6 | 7 | 0 | 0 | 0 | ± | | | | | | | |
| 1 | 9 | 2 | 8 | Alkalinity-Bicarbonate | 1 | 5 | 7 | | 0 | | 3 | 6 | 7 | 0 | 0 | 0 | ± | | | | | | | |
| 1 | 9 | 2 | 9 | Alkalinity Carbonate | 1 | 5 | 7 | | 0 | | | 0 | 0 | 0 | 0 | 0 | ± | | | | | | | |
| 1 | 9 | 1 | 5 | Hardness EDTA | 1 | 4 | 1 | | | | 3 | 2 | 0 | 0 | 0 | 0 | ± | | | | | | | |
| 1 | 9 | 3 | 2 | Acidity | 1 | 5 | 7 | | 0 | | | | | 0 | 0 | 0 | ± | | | | | | | |
| 1 | 9 | 1 | 0 | Corrosion Index | 1 | 3 | 6 | | 0 | 0 | 1 | 0 | 7 | 5 | 0 | 0 | ± | | | | | | | |
| 1 | 0 | 2 | 5 | Fluoride 1.8 | 1 | 0 | 7 | < | 0 | 0 | | 0 | 1 | 0 | 0 | 0 | ± | | | | 03 | 02 | 89 | JRG |
| 1 | 0 | 1 | 7 | Chloride 250. | 1 | 0 | 7 | | | | | 4 | 6 | 0 | 0 | 0 | ± | | | | 03 | 06 | 89 | RCS |
| 1 | 9 | 0 | 5 | Color (APHA) 15 CU | 1 | 2 | 9 | | 0 | 0 | | 1 | 0 | 0 | 0 | 0 | ± | | | | 03 | 15 | 89 | LR |
| 0 | 1 | 0 | 0 | Turbidity (FTU) 1.0 | 0 | 0 | 1 | | 0 | | | 0 | 6 | 6 | 0 | 0 | ± | | | | 02 | 27 | 88 | [illegible] |
| 1 | 0 | 2 | 7 | Hydrogen Sulfide 0.05 | 1 | 5 | 5 | < | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 0 | ± | | | | | | | |
| 1 | 0 | 5 | 5 | Sulfate 250. | 1 | 3 | 7 | | 0 | | | 9 | 4 | 0 | 0 | 0 | ± | | | | 03 | 06 | 89 | RLS |
| 1 | 0 | 4 | 0 | Nitrogen-Nitrate 10.0 | 1 | 6 | 3 | | 0 | 0 | | 0 | 1 | 5 | 0 | 0 | ± | | | | 03 | 06 | 89 | RLS |
| 1 | 0 | 3 | 9 | Nitrogen-Ammonia | 1 | 4 | 7 | | 0 | 0 | | 0 | 0 | 3 | 0 | 0 | ± | | | | 03 | 21 | 89 | JRG |
| 1 | 0 | 3 | 8 | Nitrogen-Nitrite | 1 | 6 | 3 | < | 0 | 0 | | 0 | 0 | 1 | 0 | 0 | ± | | | | 03 | 06 | 89 | RLS |
| 1 | 0 | 4 | 1 | Nitrogen-Total Kjeldahl | 1 | 7 | 5 | | 0 | 0 | | | | | 0 | 0 | ± | | | | | | | |
| 1 | 0 | 4 | 3 | Phosphate-Total (As P) | 1 | 6 | 2 | | 0 | 0 | | | | | 0 | 0 | ± | | | | | | | |
| 1 | 0 | 4 | 4 | Phosphate-Ortho (As P) | 1 | 6 | 2 | < | 0 | 0 | | 0 | 0 | 1 | 0 | 0 | ± | | | | 03 | 06 | 89 | RLS |
| 1 | 9 | 2 | 6 | Specific Conductance (u mhos/cm) | 1 | 4 | 5 | | | 1 | 0 | 8 | 7 | 0 | 0 | 0 | ± | | | | 03 | 01 | 89 | JRG |
| 1 | 9 | 3 | 0 | Total Dissolved Solids (185°C) | 1 | 3 | 9 | | | | 6 | 7 | 0 | 0 | 0 | 0 | ± | | | | 03 | 02 | 89 | HC |
| 1 | 0 | 5 | 8 | Volatile (550°C) | 1 | 3 | 9 | | | | | 1 | 0 | 0 | 0 | 0 | ± | | | | | | | |
| 1 | 0 | 5 | 9 | Fixed (550°C) | 1 | 3 | 9 | | | | 6 | 6 | 0 | 0 | 0 | 0 | ± | | | | | | | |
| 1 | 0 | 4 | 9 | Silica (as $SiO_2$) | 1 | 4 | 3 | | 0 | | | 6 | 6 | 8 | 0 | 0 | ± | | | | 03 | 06 | 89 | LR |
| 1 | 9 | 9 | 7 | Langlier Index @ 20°C | 1 | 3 | 6 | – | 0 | 0 | 0 | 1 | 1 | 2 | 9 | 0 | ± | | | | | | | |
| | | | | Bromide | | | | < | | | | 0 | 0 | 1 | | | ± | | | | 03 | 06 | 89 | RLS |
| | | | | | | | | | | | | | | | | | ± | | | | | | | |
| 30-33 | | | | LAB I.D. 0 0 0 8 0 34-38 | 39-41 | | | 42 | 43-50 | | | | | | | | 51-53 | | | | 54-59 | | | |

DATE REC: 27 [illegible]

DATE REP: MAR 31 1989

PREPARED BY: Robert O. [illegible]

The results on this report are expressed in mg/L unless otherwise indicated *A = analyst's initials

DCLS RECD.

LAB #: 909632 FEB 27 89
1-6

A-18

**Water Quality Report**

**METALS**

WSE 50

RECEIVED APR 1989 Off. of Water Programs DANVILLE REGIONAL OFFICE

**Commonwealth of Virginia**
**Department of Health**
**Division of Water Programs**
**Bureau of Water Supply Engineering**

NAME OF WATER SYSTEM: SWEET BRIAR COLLEGE
SOURCE: SURFACE WATER
OTHER INFORMATION: ~~OFFICIAL SAMPLE~~ (SDWA)

REPORT RESULTS TO HEALTH OFFICIAL AT:
Name: Office of Water Programs
Address: Danville Regional Office
1347 Piney Forest Road
City: Danville, Virginia 24540

REGION: ☐ Abingdon ☐ Culpeper ☒ Danville ☐ Lexington ☐ Richmond ☐ Virginia Beach ☐ Local Health Dept. ☐

PLANNING DISTRICT# 11
COUNTY: AMHERST
INDEPENDENT CITY:
SAMPLING LOCATION: Phy. Power Plant Office
CODE: 7-9 Sweet Briar College
SOURCE TYPE: ☒ Public-Community ☐ Public-Noncommunity

FIELD TESTS: Temp: Cl 2: mg/L CO2 mg/L
pH: Alk: mg/L Hard.: mg/L

P.W.S.I.D. #: 5 0 0 9 3 5 0 (10-16)
TRANSACTION CODE 0 3 (17-18)

DATE COLLECTED: Mo 02 Day 23 Yr 89 (19-24)

TIME: 1 6 0 1 (25-28)

COLLECTED BY: L. Mason-Viers

CONTAINER TYPE:
☐ Glass
☒ Plastic

PRESERVATIVE USED:
☐ None
☐ Ice
☐ Other
☒ Nitric Acid

SAMPLE TYPE:
D ☒ Reg. Dist.
P ☐ Plant Tap
R ☐ Raw Water
C ☐ Check
M ☐ MCL Check
S ☐ Other
29

| CONT. I.D. | CONTAMINANT NAME (Maximum Allowable Level) | | MTD. | S | ANALYSIS RESULTS | | | | | | | | PRECISION | ANALYSIS DATE Mo Day Yr | A* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1005 | Arsenic | 0.05 | 125 | < | 0 | 0 | 0 | 0 | 0 | 0 | 5 | | ± | | |
| 1010 | Barium | 1.0 | 108 | | 0 | 0 | 0 | 0 | 0 | 1 | | | ± | | |
| 1015 | Cadmium | 0.010 | 125 | < | 0 | 0 | 0 | 0 | 0 | 0 | 2 | | ± | | |
| 1020 | Chromium | 0.05 | 125 | < | 0 | 0 | 0 | 0 | 0 | 1 | | | ± | | |
| 1030 | Lead | 0.05 | 125 | < | 0 | 0 | 0 | 0 | 0 | 1 | 0 | | ± | | |
| 1035 | Mercury | 0.002 | 106 | < | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | ± | | |
| 1045 | Selenium | 0.01 | 125 | < | 0 | 0 | 0 | 0 | 0 | 0 | 5 | | ± | | |
| 1050 | Silver | 0.05 | 125 | < | 0 | 0 | 0 | 0 | 0 | 0 | 2 | | ± | | |
| 1002 | Aluminum | | 108 | | 0 | | | 0 | 1 | | 0 | 0 | ± | | |
| 1016 | Calcium | | 108 | | 0 | | 1 | 1 | 0 | | 0 | 0 | ± | | |
| 1028 | Iron | 0.30 | 108 | | 0 | | | 0 | 0 | 9 | 0 | 0 | ± | | |
| 1031 | Magnesium | | 108 | | 0 | | | 1 | 2 | | 0 | 0 | ± | | |
| 1032 | Manganese | 0.05 | 108 | | 0 | | | 0 | 0 | 1 | 0 | 0 | ± | | |
| 1051 | Strontium | | 108 | | 0 | | | 0 | 0 | 3 | 0 | 0 | ± | | |
| 1095 | Zinc | 5.0 | 108 | | 0 | | | 0 | 0 | 1 | 0 | 0 | ± | | |
| 1022 | Copper | 1.0 | 108 | | 0 | | | 0 | 0 | 1 | 0 | 0 | ± | | |
| 1042 | Potassium | | 108 | | 0 | | | 1 | 8 | | 0 | 0 | ± | | |
| 1052 | Sodium | 20. | 108 | | 0 | | | 8 | 7 | | 0 | 0 | ± | | |
| 1036 | Nickel | | 108 | | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | ± | | |
| 1007 | Boron | | 108 | | 0 | 0 | 0 | | | | 0 | 0 | ± | | |
| 1919 | Calcium Hardness | | 136 | | | | 2 | 7 | 4 | 0 | 0 | 0 | ± | | |
| 1918 | Magnesium Hardness | | 136 | | | | | 5 | 1 | 0 | 0 | 0 | ± | | |
| 1913 | Ca & Mg Hardness | | 136 | | | | 3 | 2 | 0 | 0 | 0 | 0 | ± | | |
| 1915 | Total Hardness *** | | 136 | | | | 3 | 3 | 0 | 0 | 0 | 0 | ± | | |
| 1004 | Antimony | | 125 | < | | | | 0 | 0 | 0 | 5 | | ± | | |
| | | | | | | | | | | | | | ± | | |
| | *** (Al, Ca, Fe, Mg, Mn, Sr, & Zn) | | | | | | | | | | | | ± | | |
| 30-33 | LAB I.D. 0 0 0 8 0 | 34-38 | 39-41 | 42 | 43-50 | | | | | | | | 51-53 | 54-59 | |

DATE REC:
DATE REP: 5-22-89

[illegible]EPARED BY:

The results on this report are expressed in mg/L unless otherwise i[illegible]ated. *A = analyst's initials

DCLS RECD.

LAB #: 909633 FEB 27 89

**Water Quality Report**

# PESTICIDE

WSE 50

**Commonwealth of Virginia**
**Department of Health**
**Division of Water Programs**
**Bureau of Water Supply Engineering**

RECEIVED 1989
Off. of Water Programs
DANVILLE REGIONAL OFFICE

NAME OF WATER SYSTEM: SWEET BRIAR COLLEGE
SOURCE: SURFACE WATER
OTHER INFORMATION: OFFICIAL SAMPLE (SDWA)

REPORT RESULTS TO HEALTH OFFICIAL AT:
Name: Office of Water Programs
Address: Danville Regional Office
1347 Piney Forest Road
City: Danville, Virginia 24540

REGION: ☐ Abingdon ☐ Culpeper ☒ Danville ☐ Lexington ☐ Richmond ☐ Virginia Beach ☐ Local Health Dept ☐

PLANNING DISTRICT # 11
COUNTY: AMHERST
INDEPENDENT CITY:
SAMPLING LOCATION: Phy. POWER PLANT OFFICE
CODE: 79 Sweet Briar College
SOURCE TYPE: ☒ Public Community ☐ Public Noncommunity

FIELD TESTS: Temp: pH: Cl2: mg/l Alk: mg/l CO2: mg/l Hard: mg/l

P.W.S.I.D. #: 5 0 0 9 3 5 0
TRANSACTION CODE: 0 3

DATE COLLECTED: Mo 02 Day 23 Yr 89

TIME: 1605
1609

COLLECTED BY: L. MASON-VIERS

CONTAINER TYPE:
☒ Glass
☐ Plastic

PRESERVATIVE USED:
☐ None
☒ Ice PACKS
☐ Other
☐ Nitric Acid

SAMPLE TYPE:
D ☒ Reg Dist.
P ☐ Plant Tap
R ☐ Raw Water
C ☐ Check
M ☐ MCL Check
S ☐ Other

| CONT. I.D. | CONTAMINANT NAME | (Maximum Allowable Level) | MTD. | S | ANALYSIS RESULTS | PRECISION | ANALYSIS DATE Mo. | Day | Yr | A |
|---|---|---|---|---|---|---|---|---|---|---|
| 2005 | Endrin | 0.0002 | 201 | < | 0000.0004 | | 03 | 06 | 89 | HMM |
| 2010 | Lindane | 0.004 | 201 | < | 0000.0001 | | 03 | 06 | 89 | HMM |
| 2015 | Methoxychlor | 0.1 | 201 | < | 0000.0002 | | 03 | 06 | 89 | HMM |
| 2020 | Toxaphene | 0.005 | 201 | < | 0000.0005 | | 03 | 06 | 89 | HMM |
| 2105 | 2,4-D | 0.1 | 206 | < | 0000.0003 | | 03 | 06 | 89 | HMM |
| 2110 | 2,4,5-TP (Silvex) | 0.01 | 206 | < | 0000.0001 | | 03 | 06 | 89 | HMM |

LAB I.D. 00085

DATE REC: 2/27/89
DATE REP: 3/6/89

PREPARED BY: Hazel Marshall

The results on this report are expressed in mg/l unless otherwise indicated. A - analyst initials

909634 FEB 27 89

LAB #: ☐☐☐☐☐☐ 1-6

**Water Quality Report**

# RADIOLOGICAL

WSE 50

RECEIVED
Off. of Water Programs
DANVILLE REGIONAL OFFICE

**Commonwealth of Virginia**
**Department of Health**
**Division of Water Programs**
**Bureau of Water Supply Engineering**

NAME OF WATER SYSTEM: SWEET BRIAR COLLEGE
SOURCE: SURFACE WATER
OTHER INFORMATION: OFFICIAL SAMPLE (SDWA)

REPORT RESULTS TO HEALTH OFFICIAL AT:
Name: Office of Water Programs
Address: Danville Regional Office
1347 Piney Forest Road
City: Danville, Virginia 24540

REGION: ☐ Abingdon ☐ Culpeper ☒ Danville ☐ Lexington ☐ Richmond ☐ Virginia Beach ☐ Local Health Dept ☐

PLANNING DISTRICT # 11
COUNTY: AMHERST
INDEPENDENT CITY:

SAMPLING LOCATION: Phy. Power Plant Office
CODE: ☐☐☐ 7-9 Sweet Brier College

SOURCE TYPE: ☒ Public Community ☐ Public Noncommunity

FIELD TESTS: Temp: Cl2: mg/l CO2 mg/l
pH: Alk: mg/l Hard: mg/l

P.W.S.I.D. #: 5 0 0 9 3 5 0 (10-16)

TRANSACTION CODE 0 3 (17-18)

DATE COLLECTED: Mo 02 Day 23 Yr 89 (19-24)

TIME: 1603 (25-28)

COLLECTED BY: C. MASON-VIER

CONTAINER TYPE:
☐ Glass
☒ Plastic

PRESERVATIVE USED:
☒ None
☐ Ice
☐ Other
☐ Nitric Acid

SAMPLE TYPE:
O ☒ Reg Dist.
P ☐ Plant Tap
R ☐ Raw Water
C ☐ Check
M ☐ MCL Check
S ☐ Other
29

| CONT. I.D. | CONTAMINANT NAME (Maximum Allowable Level) | MTD. | S | ANALYSIS RESULTS | PRECISION | ANALYSIS DATE Mo | Day | Yr | A* |
|---|---|---|---|---|---|---|---|---|---|
| 4 0 0 0 | Gross Alpha 15 pCi/L | 4 1 9 | | 0 0 0 1 0 0 | 0 0 3 | 03 | 02 | 89 | SAP |
| 4 0 1 0 | Combined Radium 5pCi/L | 4 2 0 | | 0 0 0 0 | 0 | | | | |
| 4 0 2 0 | Radium-226 | 4 2 1 | | 0 0 0 0 | 0 | | | | |
| 4 0 3 0 | Radium-228 | 4 2 2 | | 0 0 0 0 | 0 | | | | |
| 4 1 0 0 | Gross Beta 50 pCi/L | 4 1 9 | | 0 0 1 7 0 0 | 0 0 6 | 03 | 02 | 89 | SAO |
| 4 0 0 6 | Uranium | | | 0 0 0 0 | 0 | | | | |
| 4 1 0 2 | Tritium | | | | | | | | |
| 30-33 | LAB I.D. 0 0 0 9 5 34-38 | 39-41 | 42 | 43-50 | 51-53 | 54-59 | | | |

DATE REC: FEB 27 1989
DATE REP: MAR 06 1989

PREPARED BY: KLK

The results on this report are expressed in pCi/L unless otherwise noted. *A = analyst's initials

# Appendix D. Preliminary Cost/ Benefit Analysis of Recyled Paper Use at Sweet Briar College, Kay Pierce

In the United States, solid waste disposal and exploitation of resources are growing problems. The nation's dumps are filling and over 50% of the waste that goes into these dumps is paper products (Catalogue, p. 28). Paper is very slow to degrade once it enters the dumps. In the recent garbology research, newspapers were found from 1952 which were still perfectly readable (Abbott, p. 29). The country is also feeling the consequences of deforestation. "Every Sunday, more than 500,000 trees are used to produce the 88% of newspapers that are never recycled," (Catalogue, p. 31). Both of these problems, filling dumps and deforestation, can be reduced by recycling. In the past, Sweet Briar College has been a leader in recycling. The college has a paper collection program which turns the paper over to recyclers. But where does the paper go from there? The college does not buy it back. Can Sweet Briar be considered a true recycler when it does not complete the cycle? It is once again time for the college to take the initiative and become a leader in buying recycled paper. Though recycled paper costs more, there are benefits to the college and the community that make it worth the extra cost.

Recycling paper is more efficient than the production of paper from virgin pulp. One ton of recycled paper uses half the energy and water in comparison to the production of one ton of paper from virgin wood. Recycling also produces 74% less air pollution, saves 17 trees (each 35 ft tall) per ton, and creates five times more jobs (Catalogue, p. 16).

The only thing about recycled paper that is not efficient is the cost of buying it. Recycled paper costs more because of lack of demand. "The greatest challenge to recycling centers today is finding a market for collected waste," (Catalogue, p. 2). By increasing demand for recycled paper and decreasing demand for paper made from virgin pulp, the timber industry will become less profitable. This would encourage producers and consumers to invest in the recycled paper industry and would expand the recycling industry and encourage companies to build recycling mills rather than virgin pulp mills. This expansion would reduce the cost of recycled paper (Chandler, p. 21). Demanding recycled paper would also make a statement to the United States government which encourages much of the country's deforestation. It would discourage government subsidizing of timber removal and therefore reduce the rate of deforestation (Catalogue, p. 10).

Society is finally feeling the impact of its waste. Because of the previous facts, I have done research in the form of a brief cost-benefit analysis of Sweet Briar College switching to recycled paper.* Demand is the key to decreasing the cost of recycled paper so as to increase the number of recycling mills and decrease the number of virgin pulp mills. This would help the environment as well as bring down the costs so that individuals could also afford recycled paper. But the first step must be taken and Sweet Briar College should take it. The demand created by colleges alone would have a significant impact on the industry. In the following report I have shown that the benefits, of all kinds, are greater than the costs.

* It is very difficult to do a complete and accurate cost-benefit analysis in this case. Each administrative office and department orders the paper for their own purposes so there is no set amount of paper bought by the college. Also there are no accurate records of how much paper each office uses. In addition, most of the benefits in this analysis can not be assigned exact or even approximated monetary values.

The following table is a comparison of the costs of several types of paper** commonly used at Sweet Briar College.

| Type of Paper | Price of Paper Made from Virgin Pulp | Price of Recycled Paper |
|---|---|---|
| Zerographic | $4.90 per 1000 sheets | $7.06 per 1000 |
| Rag Cotton | $9.00 per 1000 | $13.72 per 1000 |
| Stationary | $25.60 per 1000 | $22.33 per 1000 |

** The prices of non-recycled zerographic paper and rag cotton paper were obtained from the Duplicating Office of Sweet Briar College. The prices of recycled zerographic and rag cotton paper were obtained from Conservatree Paper Company in San Francisco, California. The prices of non-recycled and recycled stationary were obtained from Central Litho in Lynchburg, Virginia. The price of non-recycled computer paper was obtained from the main computer center of Sweet Briar College. The price of recycled computer paper was obtained from Conservatree Paper Co.

The actual cost of recycled paper is generally higher than the cost of paper made from virgin pulp. There are several reasons for this. The major reason is a simple lack of demand which directly affects economies of scale. As long as non-recycled paper is most frequently used, these companies can keep the costs of production low and the prices competitive. This also keeps the recycled paper industry small in size. Because of the few number of recycling mills and companies, the costs of producing recycled paper is higher. Interestingly enough, recycled paper stationery is cheaper. Buying stationery could help offset the costs of purchasing recycled papers which are not as competitive.

There would be other costs to Sweet Briar if the college used recycled paper. The cost of shipping is higher for recycled paper. This ties in to the low demand and decentralization of a small industry. Because of the higher prices, offices would have to get together and order in bulk amounts to obtain the lowest prices. Currently at Sweet Briar, each administrative office orders its own paper.

There are benefits to using recycled paper. Environmentally concerned citizens and companies would be more likely to invest their money in a college that used recycled paper because it would be supporting the protection of the environment (Dean, Monica). Using recycled paper would also give Sweet Briar a good image in the community as well as set an example for other colleges. Sweet Briar would be a leader among colleges in the environmental movement. It would also draw in environmentally conscious and community oriented students which would be good for the quality of the college (Dean, Monica).

Individuals at the college and in the community would also be benefitted. They would be benefitted because by using recycled paper they would be bettering their environment. Also, the use of recycled paper would discourage subsidizing of timber cutting. "In 1987, The Forest Service had operational losses in about half of the forests. Since 1982, the Forest Service has spent $386 million in road building and received $32 million for timber," (National Wildlife). Taxpayers subsidize the loss; we are paying for the destruction of our national forests.

The following table sums up the main costs and benefits of Sweet Briar College using recycled paper.

| Costs to S.B.C. | Benefits to S.B.C. |
|---|---|
| Costs More | Increase support |
| Buy in Bulk | Better Image |
| Shipping Costs | Become a Leader |
|  | Attract Students |

The costs are very likely to decrease as the environmental movement progresses. As people cry out in defense of national forests, recycled paper will become a necessary solution to the problem. "With increasing numbers of states and municipalities requiring the collection of recyclables, wastepaper is piling high, and the sharp drop in wastepaper prices looks like a long-term trend," (Klevnikov, p. 108). In general, the consumption and production of recycled paper has increased (Statistical Abstract, p. 662). This will decrease shipping costs, and decrease the cost of recycled paper.

But who will make the first gesture? Sweet Briar College has the ability to be a pioneer in using recycled paper. If all colleges could be encouraged to use recycled paper, the amount of waste reduction and number of trees saved would give hope to the environmental movement. The college would not only receive benefits by using recycled paper, it would make a powerful statement at a small cost.

This paper is a first step toward addressing the cost/benefit analysis of recycled paper use at Sweet Briar College. It is limited by the amount of information that was currently available. Further steps could include defining the actual weight of different types of paper used at Sweet Briar which would facilitate an accurate economic comparisons between recycled and virgin paper use. A question which might offer us perspective would be: If Sweet Briar provided all of the pulpwood to make its own paper, how long would the sanctuaries last?

# References

Abbott, John. "Cleaning Up Our Throwaway Society," Shell News, March 1990, pp. 26-30.

Chandler, William U. Materials Recycling: The Virtue of Necessity. World Watch Paper, 1956

Dean, Monica. Director of Public Relations for Sweet Briar College.

Hassol, Susan and Beth Richman. Recycling. Snowmass, CO: The Windstar Foundation, 1989.

Klevnikov, Paul. "Who Needs Trees? There's Always the Sunday New York Times," Forbes. June 26, 1989, pp. 108, 110, 114.

Quimby, Thomas E. Recycling: the Alternatives to Disposal. Baltimore and London: John Hopkins University Press, 1975.

Recycled Paper Catalog. Earth Care Paper Inc., 1989.

U.S. Bureau of the Census, Statistical Abstract of the United States, 1989. Washington, D.C. 1989.

## Appendix E-1. Soil Conservation Service Analysis of Sweet Briar Farmland

### *Table I*

To: Sweet Briar College Farm

From: J. L. Proffitt

Date: August, 1967

Operator: Jan Osinga

Photo No: 10G-55(3)
10G-57(1)
4G-133(1)

Part A - Soil and Capability Map Legend

| Map* Symbol | Soil Name | Map Symbol | Soil Name |
|---|---|---|---|
| 2 | Mixed Alluvial Land (well drained) | | |
| 6B | Woreham fine sandy loam | | |
| 8B | Starr loam | | |
| 11B2 | Cecil fine sandy loam | | |
| 11C2 | " " " " | | |
| 11D2 | " " " " | | |
| 12C3 | Cecil clay loam | | |
| 12D3 | " " " | | |
| 15C2 | Appling fine sandy loam | | |
| 24C3 | Lloyd clay loam | | |
| 24D3 | " " " | | |
| 24E3 | " " " | | |
| 25B2 | Lloyd loam | | |
| 25C2 | " " | | |
| 25D2 | " " | | |
| 25E2 | " " | | |
| 38B2 | Dyke loam | | |
| 54D1 | Wilkes fine sandy loam | | |
| 54E1 | " " " " | | |
| 54F1 | " " " " | | |

*Numerical order, except alphabetical for published surveys.

art B- Typing

| Map* Symbol | 87 and 87a Crp,Hay & Past. | 88 Woodland | 89 Grassland |
|---|---|---|---|
| 8B | I-21 | 32 | |
| 11B2 | IIe21 | 39 | |
| 25B2 | IIe22 | 37 | |
| 38B2 | IIe22 | 37 | |
| 11C2 | IIIe22 | 39 | |
| 25C2 | IIIe23 | 37 | |
| 2 | IIIw22 | 33 | |
| 15C2 | IIIe25 | 41 | |
| 11D2 | IVe21 | 39 | |
| 25D2 | IVe22 | 37 | |
| 24C3 | IVe29 | 38 | |
| 12C3 | IVe30 | 40 | |
| 6B | Vw21 | 34 | |
| 25E2 | VIe21 | 37 | |
| 24D3 | VIe26 | 38 | |
| 24E3 | VIe26 | 38 | |
| 12D3 | VIe27 | 40 | |
| 54D1 | VIe30 | 35 | |
| 54E1 | VIIe28 | 36 | |
| 54F1 | VIIe28 | 36 | |

*List in order of LC Unit numbers.

**When this form is used the WUC will atta
individually prepared interpretations.

Land Capability Classes I - VIII

SCS-VA-87
10/1/65

Table II, p. 1

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Date August, 1967
Operator Jan Osinga
Technician J. L. Proffitt

# SOIL INTERPRETATIONS FOR CROPLAND, HAYLAND AND PASTURE

| LAND SUITED FOR CULTIVATION AND OTHER USES | | LAND LIMITED IN USES – GENERALLY NOT SUITED FOR CULTIVATION | |
|---|---|---|---|
| I | Soils that have few limitations which restrict their use. | V | Soils that have little or no erosion hazard, but have other limitations which are impractical to remove and limit their use largely to pasture, woodland, or wildlife food and cover. |
| II | Soils that have some limitations which reduce the choice of plants or require moderate conservation practices. | VI | Soils that have severe limitations which make them generally unsuited to cultivation and limit their use largely to pasture, woodland, or wildlife food and cover. |
| III | Soils that have severe limitations which reduce the choice of plants, require special conservation practices, or both. | VII | Soils that have very severe limitations which make them unsuited to cultivation and restrict their use largely to grazing, woodland, or wildlife. |
| IV | Soils that have very severe limitations which restrict the choice of plants, require careful management, or both. | VIII | Soils and land forms that have limitations which prevent their use for comercial plant production and restrict their use to recreation, wildlife, water supply and esthetic purpose |

## LAND CAPABILITY UNIT

| Number | Map Symbol | Description |
|---|---|---|
| I-21 | 8B | Deep, fertile, well-drained, brown to dark reddish-brown colluvial soils found in draws or heads of draws in association with the best of the red clay agricultural soils. Possible occasional seepage and runoff from higher lying areas. |
| IIe21 | 11B2 | Deep, gently sloping, well-drained, highly productive soils have excellent moisture supplying properties. |
| IIe22 | 25B2<br>38B2 | Gently sloping, deep, well-drained productive soils with heavy red, sometimes sticky, clay subsoils. Slight to moderate erosion. |
| IIIe22 | 11C2 | Sloping, slight to moderately eroded, deep, well-drained soils with good moisture relationships. |
| IIIe23 | 25C2 | Deep, well-drained, fertile, sloping, slight to moderately eroded soils with brown surfaces and red subsoils. |
| IIIw22 | 2 | Nearly level, somewhat poorly drained bottom soils subject to occasional overflow. |
| IIIe25 | 15C2 | Deep, well-drained, slight to moderately eroded, sloping soils with moderate coarse-textured surfaces and yellow-red clay loam subsoils. These are good tobacco soils and are responsive to good management. |

SCS—VA—87a
Continuation Sheet
10/1/65

TABLE II, p. 2

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Operator Jan Osinga
Technician J. L. Proffitt

## SOIL INTERPRETATIONS FOR CROPLAND, HAYLAND AND PASTURE

| LAND CAPABILITY UNIT | | |
|---|---|---|
| Number | Map Symbol | Description |
| IVe21 | 11D2 | Strongly sloping, slight to moderately eroded, deep, well-drained soils with red clay subsoils. Responsive to fertility increases and good management. |
| IVe22 | 25D2 | Strongly sloping, slight to moderately eroded, deep, well-drained soils with heavy red clay subsoils. Fertile soils which are productive under good management. |
| IVe29 | 24C3 | Gently sloping, very severely eroded or sloping, severely eroded, deep fertile, clay soils which have lost practically all top soil. Intensive management necessary to prevent further deterioration. |
| IVe30 | 12C3 | Gently sloping, very severely eroded and sloping severely eroded, deep, well-drained red clay soils which have lost practically all top soil. Plow layer consists of subsoil matter. |
| Vw21 | 6B | Nearly level, poorly drained, gray soils which are difficult to drain due to the lack of outlets, the heavy nature of soil material and, in some cases, seepage from higher areas. |
| VIe21 | 25E2 | Steep upland soils with slight to moderate erosion. Deep and moderately deep, well drained soils with dark red to brownish-clayey and loamy subsoils. |
| VIe26 | 24D3<br>24E3 | Sloping uplands and high stream terraces with very severe erosion; strongly sloping and steep uplands and high stream terraces with severe erosion. Moderately deep to deep well-drained soils with heavy reddish subsoils. |
| VIe27 | 12D3 | Sloping, very severely eroded and strongly sloping, severely eroded, deep, well-drained soils with red clay subsoils. |
| VIe30 | 54D1 | Sloping, severely eroded and strongly sloping, slightly eroded, shallow soils. These soils are the first to be affected by dry seasons. |
| VIIe28 | 54E1<br>54F1 | All shallow soils very severely eroded, strongly sloping land and all steep and very steep soils which lack developed subsoils. |

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UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

TABLE III

# SOIL INTERPRETATIONS FOR WOODLAND

Operator Jan Osinga
Technician J. L. Proffitt

| Woodland Suitability Group and Map Symbol | | Estimated Growth Rate – Bd. Ft. Per Ac. Per Year | | | | | | * Limitations For Use | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Lob. Pine | Sh. Leaf Pine | Va. Pine | White Pine | Oaks | Yellow Poplar | Seed Mortal. | Plant Compet. | Equip. Limit. | Eros. Hazard | Wind – throw |
| 32 | 8B | 600 | 330-450 | 380-460 | 630-740 | 210 | 580 | 1 | 1 | 1 | 1 | 1 |
| 33 | 2 | 600 | 450 | 460 | - | 210 | 380-580 | 1 | 3 | 2 | 1 | 1 |
| 34 | 6B | 460-600 | - | 280 | 630-740 | 90 | - | 2 | 3 | 3 | 1 | 2 |
| 35 | 54D1 | 460-600 | 330-450 | 380-460 | - | 90-150 | - | 2 | 1 | 1 | 1-2 | 1 |
| 36 | 54E1<br>54F1 | 330-460 | 180-330 | 280-380 | - | 90 | - | 3 | 1 | 2-3 | 3 | 3 |
| 37 | 25B2<br>38B2<br>25C2<br>25D2<br>25E2 | 460-600 | 450 | 460 | 740 | 210 | 580 | 1 | 1 | 1 | 1 | 1 |
| 38 | 24C3<br>24D3<br>24E3 | 330-460 | 330-450 | 380-460 | 500-600 | 90-150 | 200-380 | 3 | 1 | 3 | 3 | 2 |
| 39 | 11B2<br>11C2<br>11D2 | 460-600 | 330-450 | 460 | 630-740 | 150-210 | 380-580 | 1 | 1 | 1 | 1 | 1 |
| 40 | 12C3<br>12D3 | 330-460 | 180-330 | 380-460 | 500-630 | 90 | 200 | 3 | 1 | 3 | 3 | 2 |
| 41 | 15C2 | 460-600 | 330-450 | 460 | 630-740 | 50-210 | 380-580 | 1 | 1 | 1 | 1 | 1 |

* See explanations on other side.

## LIMITATIONS FOR USE

### Seedling Mortality

1. 75 – 100% survival
2. 50 – 75% survival
3. Less than 50% survival

### Plant Competition

1. No special problem
2. Release may be needed
3. Site preparation necessary

### Equipment Limitation

1. Can use equipment year round
2. Slopes 20-50% or wetness restricts use ( Less than 3 months )
3. Slopes less than 50% or wetness more than 3 mos.

### Erosion Hazard

1. No problem
2. Bush and bog harrowing in lieu of bulldozing
3. Heavy equipment restricted in site preparation, logging, etc.

### Windthrow

1. No problem
2. Stability lessened during wet or windy periods
3. Unstable due to water table or soil restriction

TABLE IV

## Table V CROPLAND SCHEDULE

| Field | Use | Section | Acres | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 199 |
|---|---|---|---|---|---|---|---|---|---|---|
| 2 LAKE | Cropland | a 2 tn lime | 4.6 | Barley (H) | Hay | Hay | Corn (S) | Corn | Corn (B) | Barl |
| | Cropland | b | 3.9 | Corn (S) | Corn ✓ | Corn (B) | Barley (H) | ~~Hay~~ Barley H HC | Hay Rye | Corn |
| | Cropland | c 2 tn lime | 4.1 | Barley (H) | Hay | Hay | ~~Corn (S)~~ Hay | ~~Corn~~ Hay | Corn (S) | Barl |
| | Natural Area | d | 2.5 | | | | | | | |
| | Total Cropland | | 12.6 | | | | | | | |
| 5 Williams | Cropland | a | 4.2 | Corn (S) | Corn ✓ | Corn (B) | Barley (H) | ~~Hay~~ Barley H Rye ACR | ~~Hay~~ Rye | Corn |
| | Cropland | b 2 tn lime | 3.2 | Barley (H) | Hay | Hay | Corn (S) | Corn Rye ACR | Corn (B) | Barl |
| | Cropland | c | 3.3 | Corn (S) | Corn ✓ | Corn (B) | Barley (H) | ~~Hay~~ Rye | ~~Hay~~ Rye | Corn |
| | Cropland | d 2 tn lime | 3.5 | Barley (H) | Hay | Hay | Corn (S) | Corn | Corn (B) | Barl |
| | Cropland | e | ~~1.9~~ | Corn (S) | Corn | Corn (B) | ~~Barley~~ Hay | Hay | Hay | Corn |
| | Natural Area | f | 4.5 | | | | | | | |
| | Total Cropland | | 16.1 | | | | | | | |
| 9 Below Orchard | Permanent Hay | a | 3.0 | | | | | | | |
| | Cropland | b 2 tn lime | 4.4 | Barley (H) | Hay | Hay | Corn (S) | Corn | Corn (B) | Barl |
| | Cropland | c | 7.3 | Corn (S) | Corn ✓ | Corn (B) | Barley (H) | Hay | Hay | Corn |
| | Cropland | d 2 tn lime | 3.2 | Barley (H) | Hay | Hay | Corn (S) | Corn | Corn (B) | Barl |
| | Cropland | e | 2.3 | Corn (S) | Corn ✓ | Corn (B) | Barley (H) | ~~Hay~~ Corn | ~~Hay~~ Corn | Corn |
| | Total Cropland | | 17.2 | | | | | | | |
| 17 | Cropland | a | 5.1 | Corn (B) | Barley (H) | Hay | Hay | Corn (S) | Corn | Corn |
| | Cropland | b | 7.7 | Hay | Corn (S) ✓ | Corn | Corn (B) | Barley (H) | Hay | Hay |
| | Cropland | c | 3.1 | Corn (B) | Barley (H) | Hay | Hay | Corn (S) | Corn | Corn |
| | Permanent Hay | d & E 4+3.7 | 7.7 4 | | | | | Barley (H) | | |
| | Total Cropland | | 15.9 | | | | | | | |
| 18 | Cropland | a | 6.8 | Corn (B) | Barley (H) | Hay | Hay | Corn (S) | Corn | Corn |
| | Cropland | b | 6.8 | Hay | Corn (S) ✓ | Corn | Corn (B) | Barley (H) | Hay | Hay |
| | Cropland | c | ~~6.6~~ 5 | Corn (B) | Barley (H) | Hay | Hay | Corn (S) | Corn | Corn |
| | Permanent Hay | d | 7.7 3 4.7 | | Corn S | ~~Corn~~ | Barley (B) | Hay | Hay | |
| | Total Cropland | | 20.2 | | | | | | | |
| 19 | Permanent Hay | a | 1.8 6.5 | | ~~Barley~~ Corn | Corn | | | | |
| | Cropland | b Hockey | 6.3 | Corn (A) | ~~Alfalfa~~ | Alfalfa | Alfalfa | Alfalfa | Alfalfa | Barl |
| | Cropland | c Lot | 1.6 5 | Corn | Corn ~~(B)~~ | ~~Barley (H)~~ | Hay Barley | Hay | Corn (S) | Corn |
| | Cropland | d Gym low | 3.4 | Corn | Corn ~~(B)~~ | ~~Barley~~ (B) | ~~Hay~~ Barley | ~~Hay~~ Barley Hay | ~~Corn (S)~~ Hay | Corn |
| | Cropland | e in upper | 4.5 | Hay | Hay | ~~Corn (S)~~ Hay | Corn S | ~~Corn~~ (B) | Barley (H) | Hay |
| | Cropland | f River | 5.4 | Corn Lower | ~~Corn (B)~~ Barley | Barley ~~(H)~~ Hay | ~~Hay~~ Corn S | ~~Hay~~ Corn | Corn ~~(S)~~ | Corn |
| | Cropland | g | 4.6 | Corn Upper | Corn ~~(B)~~ | ~~Barley~~ (H) Corn B. | ~~Hay~~ Barley | ~~Hay~~ Barl. | ~~Corn (S)~~ Hay | ~~Corn~~ Hay |
| | Total Cropland | | 25.8 | | | | | | | |

To Horse Stables

| Field | Use | Section | Acres | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 |
|---|---|---|---|---|---|---|---|---|---|---|
| 25 | Permanent Hay | stables 1985 | 4.0 | (see Conservation Alternatives) | | | | | | |
| 29 | Cropland | a | 7.3 | Corn | Corn (B) ✓ | Barley (H) | Hay | Hay | Corn (S) | Corn |
| | Cropland | b | 4.0 | Hay | Hay | Corn (S) | Corn | Corn B) | Barley (H) | Hay |
| | Cropland | c | 6.0 | Corn | Corn (B) ✓ | Barley (H) | Hay | Hay | Corn (S) | Corn |
| | Total Cropland | | 17.3 | | | | | | | |
| 31 | Cropland | | 7.2 | Alfalfa | Alfalfa | Alfalfa | Alfalfa | Alfalfa | Re-seeded Alf<br>Barley (A) | Alfalfa |
| 36 | Cropland | a | 4.0 | Corn (S,B) | Barley (H) | Hay | Hay | ~~Corn~~ Hay (S) | ~~Corn~~ Hay | Corn (B) |
| | Cropland | b | 5.5 | Corn (S,B) | Corn ( ) ✓ | Corn | Corn (B) | Barley (H) | ~~Hay~~ ALF. Rye | Hay ALF |
| | Total Cropland | | 11.5 | | | | | | | |
| 40 | Cropland | a | 5.4 | Corn | Corn (B) | Barley (H) | Hay | Hay | Corn (S) | Corn |
| | Cropland | b | 2.8 | Hay | Hay | Corn (S) | Corn | Corn (B) | ~~Barley~~ (H) Hay | Hay |
| | Cropland | c | 5.2 | Corn | Corn (B) ✓ | Barley (H) | Hay | Hay | Corn (S) | Corn |
| | Cropland | d | 4.4 | Hay | Hay | Corn (S) | Corn | Corn (B) | ~~Barley~~ (H) Hay | Hay |
| | Cropland | e | 4.1 | Corn | Corn (B) ✓ | Barley (H) | Hay | Hay | Corn (S) | Corn |
| | Cropland | f | 5.2 | Hay | Hay | Corn (S) | Corn | Corn (B) | ~~Barley~~ (H) Hay | Hay |
| | Cropland | g | 3.2 | Corn | Corn (B) ✓ | Barley (H) | Hay | Hay | Corn (S) | Corn |
| | Cropland | h | 4.8 | Hay | Hay | Corn (S) | Corn | COrn (B) | ~~Barley~~ (H) Hay | Hay |
| | Cropland | i | 2.2 | Corn | Corn (B) ✓ | Barley (H) | Hay | Hayl | Corn (S) | Corn |
| | Permanent Hay | j | 2.1 | | | | | | | |
| | Total Cropland | | 37.3 | | | | | | | |
| 42 | Cropland | a | 3.1 | Hay | Hay | ~~Corn (S)~~ Hay | ~~Corn~~ Hay | ~~Corn~~ (B) Hay | ~~Barley~~ (H) Hay | Hay |
| | Cropland | b | 5.4 | Corn | Corn (B) ✓ | Barley (H) | Hay | Hay ALF | Corn ~~(S)~~ | Corn |
| | Cropland | c | 4.8 | Hay | Hay | ~~Corn (S)~~ Hay | ~~Corn~~ Hay | ~~Corn~~ (B) Hay | ~~Barley~~ (H) Hay | Hay |
| | Total Cropland | | 13.3 | | | | | | | |
| 43 | Permanent Hay | a | 10.2 | | | | | | | |
| | Cropland | b | 5.2 | Hay | Hay | ~~Corn (S)~~ Hay | ~~Corn~~ Hay | ~~Corn~~ (B) Hay | ~~Barley~~ (H) Hay | Hay |
| | Cropland | c | 5.0 | Corn | Corn (B) ✓ | Barley (H) | Hay | Hay ALF | Corn ~~(S)~~ | Corn |
| | Permanent Hay | d | 0.3 | | | | | | | |
| | Total Cropland | | 10.2 | | | | | | | |
| 45 | Cropland | | 6.0 x4 | Hay | Corn (S) ✓ | Corn | Corn (B) | Barley (H) | Hay | Hay |
| 46 | Cropland | | 2.7 | Corn | Corn B ✓ | ~~Corn (B)~~ Barley (H) | ~~Barley~~ (H) Hay | Hay | Hay | Corn (S) |

Rt 29

| ield SA | Use | Section | Acres | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 |
|---|---|---|---|---|---|---|---|---|---|---|
| 47 Blue Barn | Cropland | 2 lim Same | 7.2 | Barley(H) | Hay | Hay | Corn(S) lime | Corn | Corn(B) | Barley |
| 48 SA Pasture | Cropland | a | 6.6 | Pasture | Pasture | Past ~~Corn~~(S) | Past ~~Corn~~ | Past ~~Corn~~(B) | Past ~~Barley~~(H) | Past ~~Hay~~ |
| 52 | Cropland | a 2T lim | 6.8 | Barley(H) | Hay | Hay | Corn(S) | Corn | Corn(B) | Barley(H |
| Below Station | Cropland | b 2T lim | 4.7 | Barley | Corn(S) | Hay ~~Corn~~(B) | ~~Barley~~(H) Corn lime | ~~Hay~~ | ~~Hay~~ | ~~Corn(S)~~ |
|  | Total Cropland |  | 10.5 |  |  |  |  |  |  |  |
| 53 Station | Cropland |  | 5.9 | Corn(S) | Corn S | Corn(B) | corn B ~~Barley (H)~~ | Barley H ~~Hay~~ | Hay | Corn(S) |
| 56 | Cropland | a | 3.7 | Hay | Hay | Corn(~~S~~) | Lime Hay ~~Corn~~(A) | Corn(B) | Corn B ~~Barley~~(H) | ~~Hay~~ Barl |
| near 6 SA Bridge | Cropland | b | 2.9 | Corn | Corn(B) | Barley(~~H~~) | ~~Hay~~ Barley H | Hay | ~~Corn(S)~~ Hay | Corn S |
|  | Cropland | c | 3.5 | Hay | Hay | Corn(~~S~~) | ~~Corn~~(A) Hay | Corn(B) | ~~Barley~~(H) corn B | Hay Barl |
|  | Permanent Hay | d | 1.1 | ---------- | ---------- | ---------- | ---------- | ---------- | ---------- | ---------- |
|  | Total Cropland |  | 10.1 |  |  |  |  |  |  |  |
| 57 | Cropland through the woods SA |  | 3.7 | Corn(S) | Corn | Corn(B) | Barley(H) | Hay | Hay | Corn(S) |
| 60 | Cropland Hale |  | 8.5 | Hay | Hay | ~~Corn S~~ Hay | ~~Corn S~~ Hay | Corn(B) | Barley(H) | Hay |

| Total Cropland Acreage | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 |
|---|---|---|---|---|---|---|---|
| Corn | 136.8 | 129.2 | 128.0 | 125.1 | 124.6 | 125.8 | 128.7 |
| Barley | 41.7 | 26.5 | 62.3 | 39.9 | 27.0 | 68.3 | 43.3 |
| Hay | 112.9 | 129.4 | 101.4 | 126.7 | 140.1 | 104.8 | 126.0 |
| Alfalfa | 7.2 | 13.5 | 13.5 | 13.5 | 13.5 | 6.3 | 7.2 |

Notes: Corn(B) is conventionally tilled corn followed by barley.
Corn(S) is no-till corn planted in grass sod.
Barley(H) is hay directly following barley.
Corn(A) is fall planted alfalfa following corn.

**Virginia Cooperative Extension Service**

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# SOIL TEST REPORT

| NOTES: |
|---|
| 2 3 |

WEET BRIAR FARM

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TABLE VI

Adj to Rt 29 & RR.

## HISTORY OF SAMPLED AREA

| SAMPLE No. | NO. OF AC. | SOIL TYPE | SLOPE | SOIL PROD GROUP | LAST CROP | | LAST CROPS FERTILIZATION, lb/A | | | LAST LIME APPLICATION | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | NAME | YIELD | N | $P_2O_5$ | $K_2O$ | MO. PREV. | T/A |
| 36A | 6 | LOAMY | MOD | 3 | CORN-SILAGE | 14 T/A | 120 | 60 | 80 | | |

## LAB TEST RESULTS

| SOIL pH | BUFFER pH | P lb/A | K lb/A | Ca lb/A | Mg lb/A | OM % | SS ppm | $NO_3$-N ppm | Zn ppm | Mn ppm |
|---|---|---|---|---|---|---|---|---|---|---|
| 5.5 | | 30<br>M | 91<br>M- | 888<br>M- | 146<br>H- | | | | | |

## FERTILIZER AND LIMESTONE RECOMMENDATIONS

FIRST CROP:

CORN (SILAGE), CONVENTIONAL TILL

| LIME, TONS/A | | FERTILIZER, LBS/A | | |
|---|---|---|---|---|
| AMT | TYPE | N | P205 | K20 |
| 2.50 | AG | 100-125 | 50 | 80 |

516. IF TOBACCO IS TO BE GROWN IN THE ROTATION IN THE NEXT THREE YEARS AND THE PH IS 5.5 OR HIGHER, DO NOT APPLY LIME. IF THE PH IS LESS THAN 5.5, APPLY ONLY ONE HALF THE LIME RECOMMENDED.

SECOND CROP:

TALL GRASS - HAY

| LIME, TONS/A | | FERTILIZER, LBS/A | | |
|---|---|---|---|---|
| AMT | TYPE | N | P205 | K20 |
| 0.00 | | 80-120 | 40 | 50 |

*134. THE N RECOMMENDATION REPRESENTS THE TOTAL AMOUNT OF N TO BE APPLIED DURING THE SEASON. APPLY THE N IN AT LEAST 2 SPLIT-APPLICATIONS.

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Ext. Form — 452-130

Reprinted August, 1983

Following is the Land-Use Plan which was adopted by the Campus Committee on Natural Resources in March, 1971, and approved by the Board of Overseers shortly thereafter. This plan was supposed to cover **a period of three years**, as noted. Shortly before the three year period expired **the Plan was extended indefinitely** by a favorable vote of the Campus Committee on Natural Resources. Since that time the various provisions in the plan have generally been followed reasonably well. As personnel changes have occurred, however, fewer and fewer College employees remain who are aware of the details of the Land-Use Plan, or even that such a plan exists. In order to provide a basis for informed discussion of future plans for the College property I have re-typed my marked-up copy of the Land-Use Plan, adhering as closely to the originally approved plan as possible, and have enclosed the attached map(s) for orientation, with numbers on the map(s) corresponding to the numbered paragraphs in the Plan. Comments on the various paragraphs have seemed appropriate, and these are included in italics under each paragraph.

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## REVISED PLAN FOR LAND USE THROUGH 1974

It is recognized that the decision on the use of all Sweet Briar property rests with the Board of Overseers, but Campus Committee on Natural Resources makes the following recommendations on use of Sweet Briar's lands through 1974:

1. Preserve and protect the area of woodland northeast of the old CCC fire trail bordering on Route 663 to the south and converging on the Sweet Briar boundary at the northern end of the area. Committee concluded: this area is not to be included in the authorized nature study areas and will be covered in the proposed timber survey.

*Protection for this area was suggested primarily because of the presence of dozens of Pink Ladyslippers under the pines in one part of the area. In the late 70s or early 80s a proposal was made to cut the area for pulpwood and replant with Loblolly Pine, which was done after very short notice, and in spite of the loss of most of the Ladyslippers.*

2. Continue to use all areas in the triangle north of Williams Creek and east of the County Road 663 just as they are now being used - let the recently cut-over pine woodland grow up naturally from its present situation rather than being replanted with Loblolly Pine. The committee concluded: the Board has approved of cutting, burning, and replanting and it is planned to proceed as authorized.

*The non-sanctuary portions of the triangle north of Williams Creek are being used for tree-farming, and are in various stages of development, a considerable part of it (mostly White Pine and Loblolly Pine plantations) having been cut for pulpwood and presumably some small saw-logs. The most recent cutting and replanting in this area was done in 1988. The sanctuary areas in that triangle remain undisturbed, and are a valuable part of Sweet Briar's Sanctuary System.*

3. (a) Extend the Ecological Studies Preserve southward to include area number 3 on the map, extending it to the north edge of Field #3, including Field #2 over to the old ditch bordering the Lake Field (Field #1). Place a gate across the access road to the Lake Field opposite the Pixley property. Committee approved this with the following exception: Mr. Osinga is to be able to use a riding trail to move his tractors over the dam at the small lake down the hill along the edge of the Ecology Study Area to get to Field #1. This was to be used, however, as little as possible.

*This proposal has been fully implemented. The Ecology Program and the Farm worked out a way that Mr. Osinga could take equipment through the developing forest to maintain a fence near the Lake Field. It turns out that the Farm has seldom used the above-mentioned dirt track to move tractors into and out of the Lake Field, and most of the severe erosion on that road is due to use by unauthorized four-wheel drive vehicles from off campus.*

(b) Continue to protect and preserve the Ecological Studies Preserve, and do not invade it to build a settling basin for the alum wash water, during the period of this plan. An agreement was reached by Buildings and Grounds and the Ecology Department that Buildings and Grounds would have control of the land below the dam to the small bridge, the lower boundary being a road used by the College to maintain the bridge. This is shown on the large map.

*The College was required to build a settling basin in order that the precipitate resulting from adding alum during the water treatment could be diverted to the sewage disposal plant rather than poured into the stream below the dam. The decision was made to build this basin close to the other water treatment units, therefore it was not necessary to invade the Williams Ecological Studies Preserve. The control of the area between the dam and (the remnants of) the small bridge was still considered to be in the hands of Buildings and Grounds, and now presumably the Physical Plant. The bridge was washed out about 15 years ago and has not been replaced, and vehicles, fortunately, have not been using the bridle trail which led to the bridge.*

4. Establish and protect a belt of natural regrowth 100 feet wide on the sides of stream #3 (100 feet on each side all the way from the lake up to the south end of the Big Oak Woodland, to begin development of a Scenic Stream resembling the primeval condition of the streams in this area. Committee approved the establishment of a 200' wide regrowth strip along the stream from the Big Oak Woodland to the lake.

*The Scenic Stream strip has been allowed to re-grow naturally, except in an approximately 100 to 200 yard distance through a pasture. A bridle trail crosses it in two places, just below the Big Oaks Woodland Sanctuary and about 200 yards upstream from Sweet Briar Lake, but the trail just below the Big Oaks which once extended 200-300 feet down the strip has been re-routed so that it goes directly across it now, therefore causing only minimal disturbance.*

5. Establish and protect an approximately 75' to 100' wide belt of natural woodland on each side of stream #3 from County Road 663 up to the source of the stream on Paul Mountain. Committee approved. ·

*Soon after Committee approval of this sanctuary, the belt of natural woodland was surveyed and mapped, mostly by students. Mr. Cronin kindly re-routed a proposed bridle trail somewhat, to protect the integrity of this strip. The area has been allowed to develop naturally, with water quality benefits which partially offset the adverse effects of excessive run-off from County Rt. 663.*

6. Measuring from the edge of the above mentioned 100' strip, or from the fence where the fields do not border the stream #3, protect with permanent hay or Christmas trees and no cultivation the bottom 100' wide up the hillside in each of the cultivated fields #1, #3, #7. Committee approved.

*These buffer strips are being maintained, with beneficial effects on water quality and wildlife.*

7. Field #4, an Ecological Studies Preserve, should be left to grow up undisturbed in a natural succession for educational purposes. Committee approved.

*This has been done and the field has been used regularly by classes in Ecology and Field Natural History, mainly to demonstrate the changes in vegetation and animal life which occur when a natural succession is allowed to occur.*

8. Field #10 and the area across the stream from it should be left alone in natural succession, partly to protect the Scenic Stream trail. Committee approved.

*By mutual agreement the upper part of this field continued to be used by the farm, most years for growing hay, while the lower portion closest to the Scenic Stream was left alone to develop naturally and help to protect the Scenic Stream. Later the upper portion was turned over to the Riding Program and fenced for use as a paddock, while the lower portion remained protected.*

9. Fence to be built around additional part of Big Oaks Woodland, fencing all but a small part of the wooded area out of the pasture, as indicated on the accompanying map. Committee approved and completed in the fall of 1970.

*This was done, leaving a small area where the heifers can find shade, yet protecting the roots of the gigantic White Oak tree from damage from the hooves of the cattle, and allowing ground cover to grow up under the tree and prevent soil erosion.*

10. The Nature Center woodland shall be protected and preserved as it is presently constructed, including a Nature Trail which has been developed. If the Natural Resources Department wished to plant more Christmas trees these could be put above the small lake south of the recent planting. Committee approved.

*This woodland has been surveyed and mapped, and because of its proximity to Guion Science Center, has been used intensively by classes in Introductory Biology, Field Natural History, Ornithology, and Ecology. Unfortunately, several hundred square feet of the sanctuary on the side toward the lake road has been bush-hogged, probably due to a misunderstanding of the exact location of the boundaries. It has been re-named the Boone-Prior Nature Sanctuary in honor of Gertrude Prior and the late Jeanette Boone - two persons who were active for years in carrying on the work of the Charles W. Carry Nature Sanctuary.*

11. Red maples should be planted in the small cemetery on the hilltop above the lake, to eventually crowd out the Paradise Trees. Mr. Edwards is to put in red maples in the cemetery. Committee approved.

*Some Red Maples were planted and two which have survived now provide shade in spring and summer, and brightly colored foliage in the fall.*

12. Protect and preserve the Carry Nature Sanctuary Outdoor Laboratory as presently constituted, south of the entrance road and including the triangle of woodland between the entrance road and the stable road. Committee approved.

*This has been done with reasonable effectiveness except for occasional invasions to cut firewood clandestinely, and perhaps on one occasion to take out a sawlog. There have been a couple of major sewer-line overflows, and some damage to the sanctuary from trouble-shooting along the sewer-line. Clean-up by bush-hogging and leaf-blowing has seemed to encroach on the sanctuary around its edges, particularly in the bottom of the East Dell.*

13. Establish a fence line, beginning from the southeast corner of the present Tucker fence and extending westward to a point past the large maple tree and part way up the hill toward House #9 on Faculty Row. Committee approved and the fence has been completed.

14. Fence the large oak grove behind Faculty Row (west) out of pasture. Committee approved and the fence has been completed.

15. It was agreed to allow Farm Manager to remove part of the Multiflora Rose Hedge along the Dairy Road in order to improve the road and repair the fence. Director of Grounds is to assist by planting a thick screen of conifers to replace this hedge.

*The Multiflora Rose Hedge was removed, and its loss compensated for to a considerable extent by item 16, below. The proposed thick screen of conifers (probably hemlocks) has been a low priority with all parties to the Land-Use Plan, and has not been established.*

16. Protect the Multiflora Rose Hedge extending south from the hockey field as an ecological study area, unless new stable road is constructed in this area. Farm Manager agreed to this point for four years. It was proposed to transplant the hedge row along the new road if and when it is developed. Committee concurred.

*This hedgerow has been maintained, with great benefit to non-game birds and other wildlife. The Farm Manager has brought up the idea of removing this hedgerow to allow farm equipment to work a larger area as a unit, without having to go up or down and around this hedgerow to get to the next field. The idea of a different, much shorter road to the riding center has been considered, but not very seriously. (A student majoring in Human Ecology in the late 1970s made a study of this possibility and even mapped out a possible route for such a road which would be much shorter and safer than the present one.)*

17. Protect the stream valley which extends down in an easterly direction from near the Green Barn, by setting aside a strip as the natural woodland is now, on each side of the stream, below the water line to its junction with the stream coming from Monument Hill. Committee approved.

*The large water main coming from the tanks on Monument Hill to the campus crosses this small stream. Protection of this small-stream valley has been maintained except in a small area where necessary inspection or maintenance of the water main has taken place.*

18. Establish a protected natural area of approximately one acre including and surrounding the spectacular patch of Tree Clubmoss (Lycopodium obscurum) near Faulconer's Store and behind the former Patchbox Antique Shop. Committee approved.

*This area has been maintained in a natural condition and ranks with some of the large White Oaks as one of the outstanding natural areas of the Sweet Briar property, although it is known to very few people. Because it is within a few dozen feet of the property line and is not more than two or three hundred feet from a private home not belonging to the College, it has been invaded a few times by children playing and people gathering firewood, but thus far with little damage. It was almost lost when a proposal to clear-cut the area was put forward, because of a mapping error by Westvaco (see enclosed Westvaco map), but fortunately Mr. Connors learned about the existence of the sanctuary and the frequent use of this general vicinity by Sweet Briar riders, and the timber sale was called off.*

19. In regard to pesticides, the main campus is to be handled by the Director of Grounds and Director of Buildings, but with the stipulation that except for an extreme emergency no DDT, aldrin, dieldrin, heptachlor, toxaphene, lindane, or 2-4-5T may be used anywhere on the property by the college or by any contractor or pest-control company. The department heads for buildings, grounds, farm, and natural resources will work together on the overall supervision of the use of pesticides so that the use of them would never go over the safe limits. Committee approved.

20. Fields #1, #3, #5, #6, #7, #8, #9 should remain in agricultural use for the period of this plan, except the lower 100' strip in specified ones. Committee approved.

21. It was suggested that the area (12-15 acres) across the railroad tracks from the main campus, which was cut over and unsuccessfully planted to pine near the garbage dump, should be converted to agricultural use. The latest recommendation by the Resident State Forester is to spot plant the lower part near the railroad; the upper section, with laps and small trees, to be run over by a large cutter available for use from the state for $2.50 per acre. The State Forester recommends that any future work on our forest lands be delayed until July 1, 1971, at which time the Government will pay $20.00 per acre towards work done in reforestation.

22. The Bear Mountain Tract should remain as a timber production area; however, it is being given a new appraisal due to a recent change in its place in future planning.

23. The San Angelo property is to be exempted from Natural Area protection, except that reasonable steps should be taken to protect the lake as a source of specimens for field work by some of the biology classes. Committee approved.

24. Any plan to cut trees covered in this plan for land use in the wooded areas reserved for timber production must be given three months notice prior to approval in order to allow time for adequate studies to be made as to what educational benefits may be destroyed. In case of emergencies such as a fire three months waiting would not be necessary before corrective action could begin. Committee approved.

*Unfortunately the exact location and extent of wooded areas reserved for timber production was not specified in this Land-Use Plan, but some details can be inferred from the accompanying map. The cumulative effect of Items 24 (above) and 25 (below) is that there should be no sudden, unannounced invasion into, or significant change in usage of any of the College lands, without allowing plenty of time for discussion in order to better balance short-term and long-term benefits of the change against short-term and long-term disadvantages in relation to the primary educational mission of the College. Item 24 specifically deals with forest land reserved for timber production, but Item 25 goes on to provide the same protection to farm land and unspecified wooded land.*

25. There should be no change in use of any farm land or unspecified wooded land without three months notice to the Campus Natural Resources Committee. Committee approved.

26. Any plan to cut the walnut trees should be deferred until the timber survey is completed except for the trees along the CCC fire trail. The Department of Natural Resources is requested to re-study the matter, and come in with the information specified under #24 above.

*This matter was re-studied and discussed in the Natural Resources Committee, and although it was acknowledged that some educational benefits might be lost by cutting the walnut trees on Paul Mountain (line 1 of Item 26), the financial benefit was judged to outweigh the potential disadvantages to the educational program, and these walnut trees were cut and sold for lumber. Surprisingly , the walnut trees on the CCC fire trail (line 2 of Item 26) were not cut , and still stand in a vulnerable location even though the fire trail has been closed off at both ends.*

27. Guidelines for the use of the various areas should include, but not be restricted to, the following:

(a) No shooting or killing of wildlife anywhere on the college property, except people can be authorized by the Assistant to the President and Treasurer to kill animals or birds detrimental to the operations of the college (example: rabid foxes, ground hogs, rats, pigeons, crows, etc.).
*Occasionally some control measures have been taken under this provision.*

(b) No target practice anywhere on property covered by this land use plan except for areas specifically designated for this purpose by the Assistant to the President and Treasurer, or by a committee selected by him.
*I believe a shooting range was set up and utilized for a while, in the old riding stable.*

(c) Vehicles can be used when necessary to maintain bridges, riding trails, cleaning out dump sites, fires or other emergencies (accidents to people, maintaining utilities, etc.).
*This was an attempt to minimize intrusion into, and damage to, the sanctuaries and other wooded lands particularly, by prohibiting the use of vehicles in most areas, except in emergencies.*

(d) Existing bridle trails will remain in use if needed. Bridle trails to be established, if needed, after consultation with persons most directly concerned with grounds, ecological study areas, Dairy Farm, and timber land.
*Almost all the bridle trails in use now have been in use for many years, and are well maintained and do no significant damage to the natural processes going on in the sanctuaries and other wooded lands. A few bridle trails have been re-routed to go around a Sanctuary instead of through it.*

(e) Motor boats are not permitted on Sweet Briar College lakes unless powered by electric motors.
*This provision has been followed completely - as far as I know there has never been a gasoline-powered motorboat on the lake in the last 25 years. Since Sweet Briar took away its own boats, however, fishermen (from off campus) have badly scarred the grass and made muddy ruts in the lawn opposite the water purification plant, as they launched their boats without a boat-ramp.*

(f) No trees are to be cut or brush to be cleared in any specified Ecological Study Area except with the approval of the Director of the Riding Program, the Director of the Ecological Study Areas, *and the Director of Natural Resources.*
*This provision has generally been followed except in a few cases of bush-hogging across the boundaries of a sanctuary, presumably due to the difficulty of delineating the boundaries.*

(g) It is understood that no trash or foreign material of any kind is to be dumped in Natural or Ecological Study Areas.
*This has been followed except in cases of individuals littering on occasion.*

(h) No plants are to be introduced into natural areas unless they were formerly native there, and the introduction is approved by the Ecological Studies Program.
*This provision has been followed generally, but we are having severe problems with plants which were introduced before this plan went into effect, and which have become pests.*

## CONCLUSION

Land use plans should be stabilized through fiscal 1974 in accord with the above plans, but at the end of that time the dairy operation, the timber operation, and the ecological studies program would be urged to present plans for an additional time period.

*In 1974 the Committee met and decided to approve extension of the Plan indefinitely.*

The persons expected to be concerned about the various operations would be the following: Farm Manager, Director of Natural Resources, Director of Grounds, Director of Buildings, and the supervisor of Ecological Studies and Natural Areas, but all other persons would be requested to report violations of the plan, and the Assistant to the President and Treasurer should be instructed to take all necessary steps to carry out the provisions of the plan.

Upon approval of this program by the Board of Overseers, appropriate publicity can be undertaken.

# Appendix E-3. Agriculture Questionnaire, Ulrike Fischer

Sweet Briar agriculture - Land Use

How much land is used for the grazing of the cows ? (acres) 400 +100 rented = 500.

How many cows are there in the dairy ? 'Herd density' (ratio land - cows)

450 total. 1/3 milking 1/3 herd replacers and 1/3 steers for beef

How much land is used for crop farming ? (acres)

350

**Historical perspective : Past / Current / Future Use**

History of Sweet Briar agriculture ... (slave plantation ...tobacco ? sheep ?)

Before 1900. Wheat and barley. & beef cattle.

**Crops:** Today.

Which ?

Hay, barley, rye and corn

How much land is used for every of them ?

140 corn
(40 small grain)
170 Hay & alfalfa (lucerne)

Hay production for the ~~Riding Center~~ / the cows ?

2½ ton / acre for dairy. none to riding center

Which practices are used in Sweet Briar agriculture:

tilling (extensive / intensive)... 6 yr. crop rotation as recommended by the Soil and Water Conservation Service

strip-cropping... yes

burning fields after the harvest... (hopefully not) for what?

Plowing... Yes for corn only. 2 years out of the 6 year rotation plan

Crop-farming : is 'waiste' from the dairy used ? ('natural' fertilizer) 100% on corn and hay field (all crop land)

not or not enough : waiste disposal… where ? ——

Composting other waiste from Sweet Briar ? Not on the farm. Building & grounds yes
Leaves etc

Crop production (in economic terms): How much is produced ? (concept of 'sustained yield')

All hay and corn consumed by the dairy cattle.
All small grain bought as concentrate feed. 16% Prote

What is the worth of this production ? (history ! Good years - bad years )

1800 ton corn silage @ $25 / ton
400 ton hay @ $65 / ton
2000 bushel of grain @ 2$^{50}$ / bushel.

How much of the crops produced on Sweet Briar get fed 'back' to the cows ?

All.

Use of chemicals in crop-farming ? Weed control only.

Fertilizers / ~~Pesticides~~ yes. N - $P_2O_5$ - $K_2O$. + trace mi

Long- release ? This depends on soil and P.H.

Chemistry…
nitrogen / phosphorous/ sulfates/ nitrates/
NH /Ammonium Hydroxytes/ (soil quality… Red Virginian Clay…soil analysis)

Whatever analysis indicates

'marginal lands' ?

Do we have any ecological problems in the Sweet Briar agriculture ('degradation')? No or very little
he fields exposed to erosion have been taken out of production

Soil erosion ? (the field right beside the dairy where the cows have to pass through every day ?)

This field is level. Looks terrible because water won't run off - (level). Please don't confuse barnyard and crop land.

Overgrazing ? All dairy cattle are f[illegible] year around.
Pasture comes as a bonus and a place to live

Pollution of the little stream flowing through the cow field ?

The many samples taken out of the stream, I have yet to get the first report on pollution.

Problems with water ? Sufficient rainfall ? Irrigation necessary ?

Using lake water at the dairy. no irrigation water

Ground water level ?

Growth depends on rainfall. Hills have [illegible] water level in the ground

Slopes… Soil-stabilizing plantings ? Crop rotation.

Use of large machinery ? Sweet Briar equipment or borrowed, for example for the harvest ?

All owned by the farm.

Combining or threshing grain done by contractor

This should get you started.

Good luck!

Jan G. Osinga Mgr.

My daughter spent 1 yr. at the Heidelberg University as a Sweet Briar Student

# Appendix E-4. Riding Center Questionnaire, Ulrike Fischer

March 8,

1) approximately 50

2) private 15/SBC 35

3) in the 1920's - expanded to the current facility in 1971

4) student enrollment , instructional program success, and an anonymous donor.

5) 0 acres "belong" to the Riding Center. The college owns the land. The Riding Center's immediate complex sits on approximately 60 acres but we use miles of hacking trails, plus pastures and fields around the campus' 3,300 acres.

6) not applicable because our horses are not field boarded year round.

7) currently, two horses not in work live "outside" to save on stall bedding and labor.

8) we make an effort to prevent overgrazing by rotating paddocks and trying to rest paddocks/fields during less heavy usage periods - we try to prevent erosion with run off troughs but not always sucessfully. Erosion is a big problem on the trails and in some of the steeper worn paths/paddocks around stable.

   We try to encourage the college to block access to trails. 4 wheel vehicles, motorcycles, pouchers do a great deal of damage. We have requested help with trail erosion.

9) exercise - ie riding/teaching in fields/rings and turning horses out to prepare them for class as well as their own health.

10) Hackers limits are set up based on safety and easy access for a low level rider who has passed tests proving she can ride safely in a small group out of the ring.

    Riding Council limits are an expansion of these areas for more experienced riders. Students with faculty review rules and trail policies approximately every 2 years.

11) The stable staff on a "piece meal" basis, keeps the riding trails open/cleared for horses, riders, joggers and hikers. We have asked the college for help with maintenance/erosion control as this is a project "bigger than us."

    Many of the trails in use for more than 50 years need erosion control.

12) Major clearing is done in the summer with updates done in Fall and Spring. If a specific trail is blocked and reported, it is usually cleared within a week, weather permitting. The stable labor does this as an extra when we can do it because no one else seems to be interested.

13) Hikers and joggers use the riding trails, also. We see no conflict in use whatever. We are opposed to vehicles. We could use some help.

14) The Manager of the Rogers Riding Center and Stable is responsible for the management of the Rogers Riding Center under the directon of the Director of Riding. The Riding Program is a part of the Department of Physical Education and Athletics and as with other teaching facilities is served by Service Master for building and lawn maintenance. There is no responsibility to or for the Dairy except where we have panels and gates through their pastures.

continued -

ation Ricki Fischer's questionnaire: March 8, 1990

15) Please see Riding Program Handbook and college catalogs. We already have a mission statement for Sweet Briar College Riding. We are also part of the Physical Education and Athletics Department and fall under its mission and of course the mission of Sweet Briar College. Our budget is submitted through the Dean's Office and is reviewed at least in general by the faculty budget representative and the same process as all Education Departments.

The budget process for an auxiliary service such as the Dairy is overseen by the Vice President and Treasurer of the college and not the Dean of the College.

16) Horses eat a pelletted sweet feed and oats mixture orginally formulated for us by our veterinarian and the feed company and is now sold commercially. They eat approximately 40 tons per year. This is supplemented by a good quality timothy or orchard grass hay purchased primarily from a hay dealer in the Shenandoah Valley. We feed approximately 185 tons per year. We generally do not buy hay from the Sweet Briar Farm because they can not provide us with a regular supply of quality horse hay.

17) 18) 19) 20)

Stalls are cleaned daily - approximately 40-50lbs. of used peanut hull bedding and manure per horse per day is removed. It is composted in two large piles east of the Riding Center. Decayed hulls are spread on the riding paddocks and fields as natural fertilizer (very high nitrogen content), erosion control and seeding cover. The college's Grounds crew uses it too for mulch around campus and we sell truck loads of it to gardener's using the money to keep the the pile maintained and repurchase bedding. At this time, the Dairy chooses not to use this product.

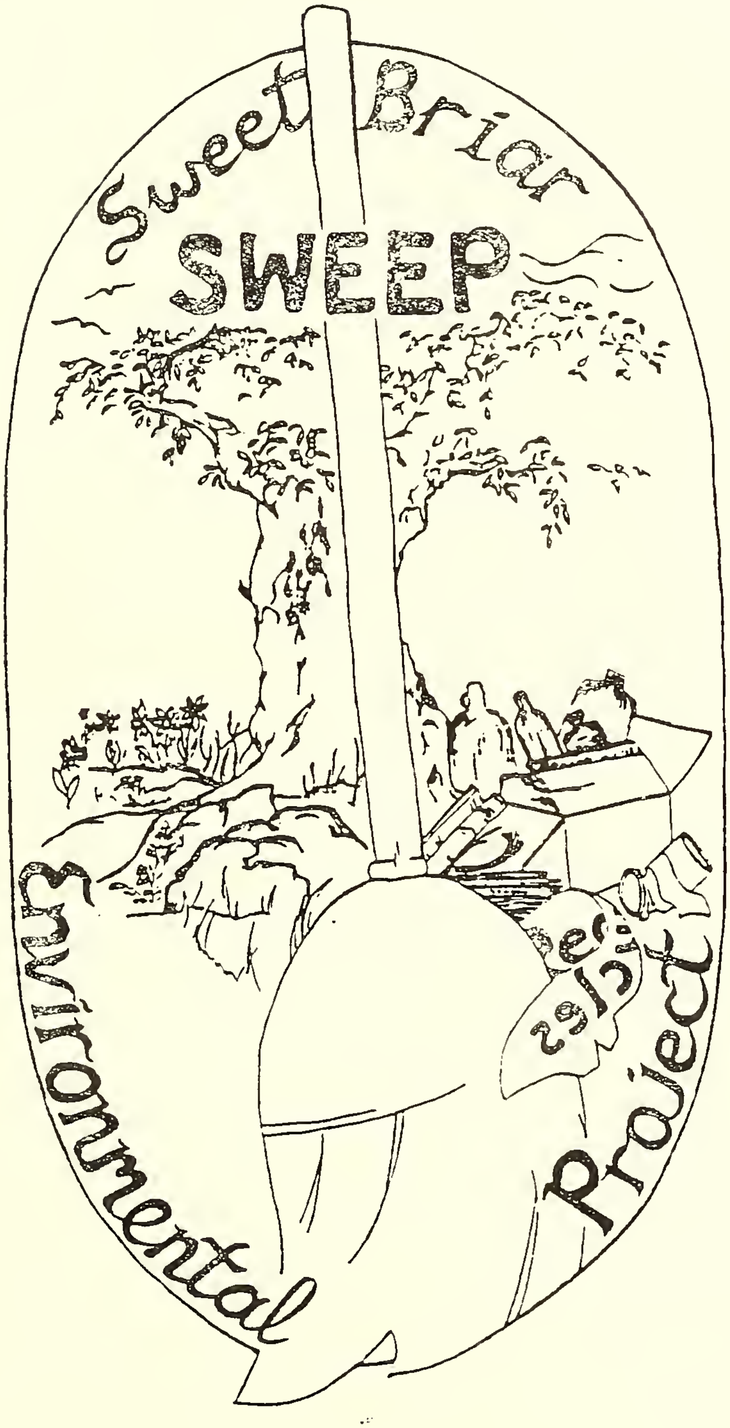
21) The ring footing is a mixture of sand and wood shavings purchased commercially. The stalls are bedded primarily in peanut hulls and in some summer months in sawdust purchased from a local lumber yard. The college has no milling operation.

22) The Riding Program uses laundry soap to wash its saddle pads and blankets; dishwashing soap for the horses and feed tubs; castile and saddle soap for cleaning the tack; a powdered pioson for fly control (nothing larger than a fly can enter containers, no spillage or leakage); for additional fly control, a fly spray on the horses and fogger in the stables only; nitrogen and sometimes potash or lime on the fields when overseeding.

23) Because the Riding Center is a teaching facility and the Dairy/Farm is a commercial operation, they are managed differently and seperately. We share use of the grazing fields with the Dairy maintaining the fencing and the Riding Program maintaining the teaching stations/jumps. Feed, supplies and medications for horses and cows are different enough that combined ordering is not advantageous, but local suppliers realize the benefit of having the combined Sweet Briar account.

Please make an appointment to see Paul Cronin if you have further questions.

Appendix F-1. SWEEP Emblem



## Appendix F-2. Goals of SWEEP

I. Responsible disposal of campus waste
- A. Promote collection of aluminum in designated sites (dorms, buildings in which drink machines are located)
- B. Promote collection of high grade paper in all offices and classroom buildings
- C. Promote the depositing of glass, high grade paper, aluminum, newspapers, magazines, recyclable plastics, chipboard, grocery sacks, and cardboard in the trailer for recycling
- D. Explore with food services how they might participate in recycling

II. Reduction and/or redirection of waste production
- A. Reduce paper consumption while continuing to communicate effectively
    1. Encourage use of bulletin boards and notices in campus publications rather than mass flier distribution
    2. Encourage double-sided use of paper in copying
    3. Explore reduction in use of nonbiodegradable products, targeting food services, bookshop, and physical plant operations
    4. Explore use of recycled products wherever possible

III. Education of immediate and greater communities
- A. Disseminate information through campus publications
- B. Pursue programming on campus radio
- C. Distribute pamphlets and/or posters
- D. Institute special "Sweep Up" days, having volunteers at the trailer to help those who need it
- E. Look for campus activities throughout the year in which SWEEP can be visible.

## Appendix F-3. Recyclable Papers & High Grade

(Paper Clips and Staples Do Not Need to be Removed Before Recycling)

Binders with papers (when practical, save binders for reuse)
Bond Paper
Booklets
Carbonless Forms
Cellophane-windowed Envelopes
Colored Papers
Company Bulletins, Flyers, and Newsletters
Computer Print-outs
Copier Paper wrappers
Envelopes
Manila Folders (all colors)
Mixed Papers
Pads with gummed backing
Pamphlets
Plastic-windowed Envelopes
Surplus Forms
Tabbed Dividers (even if coated with small amounts of plastic)
White Ledger
Writing Tablets (used)

Forms or documents that are boxed or wrapped in cellophane can be recycled without removing from their packages

### Non-recyclable Materials

No Newspaper + slick paper
Carbon Paper
Foam Cups, Plates, and Trays
Papers contaminated with food waste
Used Paper Cups, Plates, and Towels
Waxed Paper

### MUST SHRED

The following documents must be shredded before being recycled:

Any documents that are highly sensitive
(Service Plans, Business Plans, Strategic Plans, New Venture Plans, Product/Invention Information, Personally identifiable employee information, etc.)

**SWEEP RECYCLING PROJECT**

## Appendix F-4.

## TOTALS COLLECTED AND RECYCLED
November 1988- November 1989

Sweet Briar Environmental Project: SWEEP

| | | RATE | PROCEEDS |
|---|---|---|---|
| | | | #77.50 |
| Aluminum | 947 lbs. + 310<br>100 | $.25 to$.30 per lb. | $261.50 +25.00 |
| Glass | 6780 lbs + 2020<br>1700 | $1.00 per 100 lbs. | 20.20<br>67.80 + 17.00 |
| High grade paper (ledger paper) | 3750 lbs 1000<br>+1400 | $1.00 per 100 lbs. | 10.00<br>37.50 + 14.00 |
| Cardboard | 2000 lbs. 400<br>200 | approx. $.75 per 100 lbs. | 12.25 |
| Magazines/ slick paper<br>Newspaper<br>Chipboard<br>Grocery sacks | 36,100 lbs + 8620<br>6600 | ——— | 25.90 |
| Miscellaneous | 1450 lbs | ——— | ——— |
| TOTALS | 53,027 lbs. + 11,990<br>10,000<br>(26.5 tons) | | $404.95<br>107.70<br>56.00<br>$568.65 |

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